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IFPRI Discussion Paper 00739

December 2007

Income Growth and Gender Bias in Childhood Mortality in Developing Countries

Mika Ueyama

Food Consumption and Nutrition Division

INTERNATIONAL FOOD POLICY RESEARCH INSTITUTE

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IFPRI's research, capacity strengthening, and communications work is made possible by its financial contributors and partners. IFPRI gratefully acknowledges generous unrestricted funding from Australia, Canada, China, Denmark, Finland, France, Germany, India, Ireland, Italy, Japan, the Netherlands, Norway, the Philippines, Sweden, Switzerland, the United Kingdom, the United States, and the World Bank.

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PUBLISHED BY

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ACKNOWLEDGMENTS

I am grateful to Takashi Kurosaki, John Hoddinott, Mary King, and Osamu Saito for many comments and helpful suggestions. I also thank the participants of seminars at Hitotsubashi University, the 14th Annual IAFFE Conference, the Annual Meeting of the Population Association of Japan, and the Fall Meeting of the Japanese Economic Association. All remaining errors are my own.

ABSTRACT

With poverty studies having shifted their focus from household poverty to individual poverty, a number of studies have started to examine intrahousehold resource allocation, especially gender bias within the household as potential causes of poverty. The literature has highlighted the existence of gender inequalities in South Asia, attributed to strong preferences for male offspring stemming from cultural and traditional customs. Only a few studies focused on the regional difference in the extent of gender bias and its response to income growth. To fill a void in previous studies, this study analyzes regional differences in gender discrimination, taking into account time-series variations. Furthermore, we test whether economic factors are responsible for gender bias in child mortality.

There are two main objectives in this study. First, through a comprehensive literature review and a careful treatment of data compilation, regional features and recent trends in gender bias in children's health outcomes are updated. We find strong evidence of severe disparity in child health against girls in South Asia; in contrast, no such anti-female gender bias exists in Sub-Saharan Africa.

Second, this paper empirically tests the relationship between gender biases in child mortality and income growth using carefully-compiled new country-level panel data, paying attention to the possibility that such relationship differs between regions and changes over time. To investigate the relationship, two types of data sets are used: (1) new cross-country panel data of childhood mortality rates by sex, collected from various sources of macro statistics, such as DHS stat and WHO statistics; and (2) our own estimates for age-specific child mortality rates of children, constructed from the retrospective information on birth and death histories included in micro data of each round of the Demographic and Health Surveys (DHS).

The empirical result suggests that income growth is correlated with the reduction of the anti-female bias in childhood mortality in most regions of the developing world—including South Asia. This result is reasonable, since income growth leads to an increase in nutrition intake (food consumption) and in health related inputs. In sharp contrast, the regression result does not show any significant correlation between gender biases in child health outcomes and income growth in Sub-Saharan Africa. While previous studies focused on the severe gender bias in South Asia, this study examined the correlation between income growth and gender bias and found a new dimension of regional contrast between Sub-Saharan Africa and other regions.

Key words: Gender bias; intrahousehold resource allocation; childhood mortality; South Asia; Sub-Saharan Africa, developing countries

1. INTRODUCTION

Over the past few decades, a number of studies have examined intrahousehold resource allocation, especially gender discrimination within the household. This parallels the recent development in poverty analyses in developing countries that have shifted their focus from the question of "which household is poor" to the question of "who is poor." The main question addressed in the emerging literature on intrahousehold resource allocation and poverty is how households allocate their resources among household members, especially among children, when the size of a household is large and when they face severe income constraints. This is exactly the question this study tackles.

A number of studies have pointed out the existence of anti-female bias in measures such as sex ratios of population, food distribution, human capital investment, time allocation, and expenditure patterns. Among them, Sen's study of "missing women" shocked the world (Sen 1990). He pointed out that abnormally high male-female population ratios in South Asia and North Africa indicate the existence of extreme anti-female gender bias in these regions. Regarding health and nutritional aspects of children, the existing literature has shown that such gender discrimination is quite severe in South Asia, while it is rarely observed in Sub-Saharan Africa (see Section 2 for the literature review).

One aspect that has not been adequately analyzed in the literature is regional differences in the extent of gender discrimination and its response to income growth. Most existing studies on gender differences in child health outcomes are limited to descriptive analyses based on time-series data for a specific country or one-time cross-country data. They tend to attribute gender discrimination solely to social and cultural aspects such as religion and traditional norms, ignoring income constraints.

Unlike these studies, this paper empirically tests the relationship between gender bias in child mortality and income growth using country-level panel data. Due attention is paid to the possibility that such a relationship differs among regions and changes over time. To investigate the relationship, two types of data are used: (1) new cross-country panel data of childhood mortality rates by sex, which were collected from various sources of macro statistics, such as the Demographic and Health Survey (DHS) STAT compiler and World Health Organization (WHO) statistics; (2) original estimates for mortality rates of children, which were constructed using the retrospective information on birth and death histories included in micro data of each round of DHS surveys.

This study contributes to the existing literature in three ways. First, through a comprehensive review and a careful treatment of data compilation, regional characteristics and recent trends in gender discrimination in health outcomes of children are updated. Second, the impact of income growth on gender bias in childhood mortality is examined carefully using new cross-country panel data. The result shows that income growth is significantly associated with the reduction of the anti-female discrimination in childhood mortality in most regions of the developing world—including South Asia. This finding questions the validity of the view adopted in the existing studies that severe gender discrimination in various dimensions in South Asia is likely to persist because the discrimination can be attributed to region-specific cultural factors and not to economic factors. This study instead suggests that with future growth in income in South Asia, the gender bias in childhood mortality is likely to decline. Third, the regression analysis shows that the above relation does not apply to Sub-Saharan Africa. There is no significant correlation between gender bias in child mortality and income growth in that region.

The rest of this paper is organized as follows: Section 2 comprehensively reviews the literature on intrahousehold resource allocation related to child health, in particular, gender differences in food consumption, distribution of health inputs, and health outcomes (anthropometric outcomes and mortality) among children. Section 3 describes the regional characteristics and time trends in gender bias in mortality of children. Section 4 focuses on the relationship between income and the gender discrimination in childhood mortality. How income growth affects changes in boy-girl differences in mortality is further discussed in Section 5, through regression analyses. Section 6 concludes the paper, highlighting key empirical results.

2. LITERATURE REVIEW: GENDER BIAS IN CHILD HEALTH AND NUTRITION

Since the early 1980s, many researchers have focused on intrahousehold differences in resource allocation, especially those affecting gender differences in child health outcomes. In particular, nutritional anthropologists and demographers have conducted numerous studies on differences in food-intake or nutritional status within the household. Most of the early studies examine the gender bias in South Asia, for instance, D'Souza and Chen (1980) and Chen, Huq, and D'Souza (1981) on Bangladesh, and Miller (1981) and Sen (1984) on India. The reasons that most studies focused on South Asia are the following: (1) data availability, (2) accumulation of existence studies (particularly anthropology and population studies), and (3) the well-known fact of significant gender disparities in South Asia. These early studies described severe anti-female discrimination in South Asia, and established a new field of empirical studies of intrahousehold resource allocation in child health as one of the key aspects of economic development.

Rosenzweig and Schulz (1982) is the first study to rigorously investigate gender bias in child mortality through econometric analyses. They explain that higher mortality among girls in India is attributed to rational behaviors of parents; in other words, girls' high mortality rates are the result of gender differences in investment among children, taking into account the future expected income from children. Since this is the first study that strictly investigates gender bias as a function of economic returns given individual endowments, the study had an enormous influence on researchers who are interested in gender differences in resource allocation.

From the demographic points of view, Das Gupta (1987) concludes that the anti-female bias of under-five mortality in India does not decrease even if the economic condition improves. Her argument ushers in further research into gender disparities that still remain even with income growth and fertility decline in South Asia (Kishor 1993; Das Gupta and Bhat 1997; Clark 2000; Bhargava 2003; Bhat and Zavier 2003).[1]

Table 1 summarizes the studies on gender differences in child health in developing countries.[2] Two types of indicators are commonly used to examine intrahousehold differences in child health. The

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[1] Over the last decade, the focus of demographers has shifted from a simple analysis of gender differences in mortality rates to more complex relationships between fertility declines, child mortality, and the parents' preferences for sons and daughters, including the issues of sex-selective abortions and female feticide as a result of a diffusion of prenatal sex-diagnostic techniques. For instance, some studies suggest that a high degree of gender discrimination (preferences for sons) persists in India, even if "mortality inequality" (boy-girl differences in mortality rates) is reduced. This is because gender inequality shifted from "neonatal inequality," such as differences in distribution of food and health care inputs among children, to "natal inequality" as typified by the incidence of sex-selective abortions. In fact, the juvenile sex ratio (the ratio of males to females) has been increasing in India (for a review, see Bhat 2002).

[2] A study by Haddad et al. [1996] is a comprehensive and in-depth review of gender differences in the food consumption and nutrition literature until the first half of the 1990s. Some of Table 1 draws upon Haddad et al. (1996), Dasgupta (1993), and Strauss and Thomas (1995).

first is intrahousehold resource allocation in health inputs, indicated by food (nutrients) consumption and nonfood (health-related) inputs. Also, the outlay equivalent approach for an "adult good," such as tobacco or alcohol, has been proposed as a parsimonious technique for examining intrahousehold resource allocation.[3] The second indicator is about health outcomes, such as mortality and anthropometric outcomes. A number of studies have focused on gender bias in mortality and anthropometric outcomes of children, since the evaluations of gender inequality using health outcome indicators are more accurate and easier than input indicators, such as individual food consumption.[4] In addition, reducing mortality and malnutrition of children is one of the important objectives of development. Thus, many researchers focus on these issues, especially in South Asia and Sub-Saharan Africa.

In this table, results of previous studies are classified into three groups according to the extent of gender bias: anti-female bias, no gender bias, and pro-female bias. Also, the table is divided by geographical regions to highlight regional characteristics of gender biases. Analytical foci of the studies are differentiated by five measures, represented by different markers: food (calorie) intake (*), nonfood health inputs (+), anthropometric outcomes (#), child mortality ($), and "adult goods" consumption (\).[5]

South Asia

The most striking evidence is the extreme anti-female biases in South Asia. In terms of food consumption and nutrition intakes, descriptive studies in the 1980s found significant anti-female biases (for example, Cowan and Dhanoa 1983 in India, Levine 1987 in Nepal, Carloni 1981 in Bangladesh). However, subsequent studies in the 1990s found little gender differences in nutrient adequacy when controlled for activity levels and body weight (Pitt, Rosenzweig, and Hassan 1990 and Ahmed 1993 in Bangladesh; Gittelsohn 1991 in Nepal).

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[3] The basic idea behind this technique is to test whether parents reduce expenditures on these adult goods for an extra girl than for an extra boy. The advantage of this method is that individual consumption data are not necessary, but household expenditure data on adult goods can be used.

[4] See Behrman and Deolaliker (1988) and Ueyama (2006) for the measurements of health conditions.

[5] Gender differences in food intake, nonfood health inputs, and adult goods consumption represent inequality in the distribution of health inputs between boys and girls. Gender differences in the health condition of children are represented by gender biases in mortality rates and anthropometric outcomes.

Table 1. A summary of studies of gender bias in child health

Area	Anti-female bias	Neither favored	Pro-female bias
			Christian et al. 1989
South Asia	#,$Sen 1984	*,#Ryan et al. 1984	#(India)[a]
		Alderman and Garcia 1993	
	#Sen and Sengupta 1983	#(Pakistan)	
	*Behrman 1988b (India)	#Basu 1993a (India)	
	*Brown, Black, and Becker 1982 (Bangladesh)	*Ahmed 1993 (Bangladesh)	
	*,$Chen, Huq, and d'Souza 1981 (Bangladesh)	*Gittelsohn 1991 (Nepal)	
	*Levine 1987 (Nepal)	*Behrman 1988a (India)	
		Behrman and Deolalikar 1990	
	#Ahmed 1993 (Bangladesh)[b]	*(India)	
		Ahmed and Morduch 1993	
	#HKI 1993 (Bangladesh)	\(Bangladesh)	
	+Pettigrew 1986 (India)	*Pitt, Rosenzweig, and Hassan 1990 (Bangladesh)	
	+Das Gupta 1987 (India)		
	Rosenzweig and Schultz 1982		
	$(India)		
	D'Souza and Chen 1980		
	$(Bangladesh)		
	Muhuri and Preston 1991		
	$(Bangladesh)		
	Murthi, Guio and Drèze 1995		
	$(India)		
	$Kishor 1993 (India)		
	*Carloni 1981 (Bangladesh)		
	$Miller 1981 (India)[c]		
	Basu 1993b (Review of South		
	$Asia)		
	Dasgupta 1993 (Review of		
	$South Asia)		
	Abdullah and Wheeler 1985		
	*(Bangladesh)		
	Cowan and Dhanoa 1983		
	*(India)		
	Sabir and Ebrahim 1984		
	+(Pakistan)		
	Fauveau et al. 1990		
	+(Bangladesh)		
	Subramanian and Deaton		
	\1990 (India)		
	*,#,		
	$Sen 1981		
	$Drèze and Sen 1989		
	Alderman and Gertler 1997		
	+(Pakistan)		
	*,+Borooah 2004 (India)		
	#Sain 1994 (India)[a]		
	$Maharatna 2000 (India)[a]		
	Alderman and Gertler 1989		
	#(Pakistan)		

Table 1. Continued

Area	Anti-female bias	Neither favored	Pro-female bias
	$Bhargava 2003 (India) $,(#+)Basu 1989 (India)[d]		
Sub-Saharan Africa	#,$Klasen 1996 #Schnepf 1992 (Rwanda)[n]	\Deaton 1989 (Côte d'Ivoire) #Kennedy 1989 (Kenya) #,$Svedberg 1990 #,$Svedberg 1996 *,#,$Hardenberg 1992 (Madagascar) Caldwell and Caldwell 1992 Haddad and Hoddinott 1992 \(Côte d'Ivoire) Haddad and Reardon 1993 \(Burkina Faso) Haddad and Hoddinott 1994 #(Côte d'Ivoire)	#,$Svedberg 1991 (many African countries) #Teklu, von Braun, and Zaki 1991 (Sudan) Kennedy and Cogill 1987 #(Kenya) #von Braun, de Haen, and Blanken 1991 (Rwanda)
East and Southeast Asia	*Chula, Karangka, and Onate 1980 (Philippines) *Evenson, Popkin, and King-Quizon 1980 (Philippines) $Ren 1995 (China)	*Aligaen and Florencio 1980 (Philippines) *Bouis and Peña 1997 (Philippines) +,\Bouis et al. 1993 (Philippines)	#Bouis and Haddad 1990 (Philippines)
Middle East and North Africa	$Yount 2001 (Egypt) +Yount 2003a (Egypt) $,+Yount 2003b (Egypt)		
Latin America	*Frongillo and Begin 1993	Heller and Drake 1979 +(Colombia) #von Braun, Hotchkiss, and Immink 1989 (Guatemala) *,#Leonard 1991 (Peru) #Johnson and Rogers 1993 (Dominican Republic)	

Notes: * food consumption (calorie intake); + nonfood health inputs, breastfeeding, morbidity; # anthropometric outcomes; $ mortality; \ "adult goods" consumption.

[a] The object of their study is Indian tribes.
[b] Gender differences were not statistically significant.
[c] Review of patterns of mortality for boys and girls in North and South India.
[d] In terms of mortality rate of children under 5 years, anti-female discrimination was obvious both in Tamil Nadu and in utter Pradesh. On the other hand, severe malnutrition (measured by anthropometric indicators) was more prevalent among boys than girls in Utter Pradesh, while the converse was shown in Tamil Nadu. Gender differences in the use of health services were more complex. No clear-cut evidence was revealed.

Empirical studies using the International Crops Research Institute for the Semi-Arid Tropics) (ICRISAT) database in India showed conflicting results (Harriss-White 1997). Ryan et al. (1984), which is the first being used as a reference research using the ICRISAT data, did not find any significant gender differences among children in nutrients intakes as well as in anthropometric measures. Also, Behrman and

Deolaliker (1990) found little evidence that anti-female discrimination in nutrient levels or in nutrient intake variances exist. However, they found gender-specific adjustment to changes in food prices. Consequently, they inferred that the relatively greater vulnerability of women and girls during rising food prices could be characterized as gender discrimination. Conversely, Behrman (1988b) showed weak but statistically significant anti-girl bias in the lean season.

Although there have been only a few studies examining gender bias in nonfood consumption and health inputs, empirical results found consistent anti-girl discrimination in the duration of breast-feeding, quantity and quality of health care, and survival probabilities after a disease.[6] Indeed, wider gender differentials seem to exist for medical care than in food allocation (Das Gupta 1987). The evidence from the adult goods outlay equivalent approach is inconclusive. Subramanian and Deaton (1990) found the existence of discrimination against girls, while Ahmed and Morduch (1993) concluded no significant boy-girl differences.

Numerous studies have examined gender discrimination in health outcomes among children. Overall, girls tend to have a worse health condition than boys in South Asia; while no significant gender bias (or a little pro-female bias) is consistently found in Sub-Saharan Africa. In terms of child mortality, a large number of studies have found an excess mortality of girls relative to boys in South Asia (d'Souza and Sen 1980; Sen 1981, 1984; Miller 1981; Dréze and Sen 1989; for a review, see Basu 1993b and Dasgupta 1993). The results are mixed for gender differences in anthropometric outcomes; a majority of studies (Ahmed 1993 and HKI 1993 for Bangladesh, and Sen and Sengupta 1983 and Sain 1994 for India) revealed anti-female discrimination, while some studies (Ryan et al. 1984 for India and Alderman and Garcia 1993 for Pakistan) showed no significant gender differences.

However, the degree of gender bias varies by regions and socioeconomic groups within South Asia. For instance, it is well recognized that anti-female discrimination is much weaker in South India than in North India.[7] In addition, upper-middle caste, propertied groups and more educated are more

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[6] While the incidence of diarrhea is biologically higher for boys than for girls, Faveau et al. (1990) showed the risk of dying from diarrhea among children who are severely malnourished is more than twice as high among girls as among boys.

[7] Some demographers consider that the dominant Aryan culture of the North—with its emphasis on caste hierarchy, patrilineal inheritance, and male kinship patterns—is different from the Dravidian culture of the South, where women play a prominent part in society and in economy (Borooah 2004; Financial Times, 8/9 February, 2003).

likely to have preference for sons.[8] Furthermore, in general, tribal societies are more gender-equal and balanced than the non-tribal population (Christian et al. 1989; Maharatna 2000).[9]

Sub-Saharan Africa

In contrast to the evidence from South Asia, a majority of studies found insignificant boy-girl differences in child heath in Sub-Saharan Africa. Although empirical studies using food and nonfood consumption are limited, Hardenbergh's (1992) study on Madagascar and Haddad and Hoddinott's (1994) analysis on Côte d'Ivoire found no significant gender bias.

Empirical works based on the adult goods approach also found no significant gender discrimination in Sub-Saharan Africa. Deaton (1989) and Haddad and Hoddinott (1992), using data from Côte d'Ivoire, found no gender discrimination against girls. Likewise, Haddad and Reardon (1993) did not find any anti-female discrimination in Burkina Faso.

Regarding gender differences in health outcomes among children, a number of studies have shown no gender bias in Sub-Saharan Africa. In contrast to findings from South Asia, a majority of studies in Sub-Saharan Africa consistently indicate absence of anti-female discrimination in childhood mortality (Svedberg 1990, 1991, 1996; Pinstrup-Andersen 1991; Caldwell and Caldwell 1997).[10] Moreover, evidence from anthropometric indicators is particularly strong in Sub-Saharan Africa. For example, cross-country studies by Svedberg (1990, 1991, 1996, 2000) found noteworthy evidence of no anti-female discrimination in most of Sub-Saharan African countries. Hardenbergh (1992) also found no significant gender differences in anthropometric outcomes, as well as in childhood mortality in Madagascar.

On the whole, it is clear that there is no significant anti-female bias in intrahousehold allocation of child health in Sub-Saharan Africa.

Other Regions

There are few empirical studies on gender bias in food and nonfood consumption among children in other regions. It is still unclear whether anti-female disparities exist (or existed) in Southeast Asia, while some

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[8] For instance, Cowan and Dhanoa (1983) showed that anti-female discrimination in food consumption is more severe in privileged families than in the poorest families. Bhat and Zavier (2003) pointed out reasons why religion, caste, and social status have a strong influence on the preference for sons. First is the marriage custom among the higher caste. A majority of the higher caste gives dowries at the marriage of their daughters, in contrast with a tradition of bride-price with Muslims and in lower caste groups. Second, religious reasons are also important. For example, higher caste Hindus have the preference for sons because only sons could perform religious rites for parents. Also, the "purdah" system, which is the seclusion of women practiced in South Asia, is well known as a key factor that inhibits women's autonomy and economic activities.

[9] Maharatna (2000) suggests that less anti-female biases among tribal societies is attributed to tribal women's higher economic worth, resulting from their higher labor force participation. This means that gender bias in tribal societies can be explained as a function of market returns rather than only cultural factors.

[10] See Svedberg (2000) for a comprehensive review of malnutrition of children in Sub-Saharan Africa.

studies examined gender bias in food intakes in the Philippines. Earlier studies found anti-female bias in food intakes (Chula, Karangka, and Onate 1980; Evenson, Popkin, and King-Quizon 1980), while others, for example, Bouis and Peña (1997), concluded that the gender bias in food intakes disappears when adjusted for body weight and activity. In Latin America, there is only a handful of empirical studies, but the majority of them found no boy-girl differences in food consumption.

Regarding the gender bias in child health outcomes, Yount (2001, 2003b) found evidence of anti-female differences in child mortality in the Middle East and North Africa.[11] Likewise, studies in China showed anti-female discrimination in mortality in children (Coale and Banister 1994; Murphy 2003). In Latin America, studies by von Braun, Hotchkiss, and Immink (1989) in Guatemala and Johnson and Rogers (1993) in the Dominican Republic found no gender differences in anthropometric outcomes of children.

International Comparisons (Cross-Country Studies)

International comparisons through cross-country regression analyses are still few, but some examined regional characteristics of gender inequality. Among them, many of them used the Demographic and Health Survey (DHS) (for example, Arnold 1992, Hill and Upchurch (1995), Filmer, King, and Pritchett (1998).

Using 38 DHS surveys from 35 countries, Hill and Upchurch (1995) found that anti-girl bias in child mortality is much more severe in most developing countries than would be expected, given the experience of European-origin populations at similar levels of mortality. Anti-girls discrimination is particularly present in the countries of the Middle East (Egypt) and South Asia (Pakistan). Regarding morbidity, malnutrition, and immunization, in contrast, they did not find any significant gender differences. In addition, they found the extent of gender bias is mostly uncorrelated with the absolute level of health indicators.

Filmer, King, and Pritchett (1998) also showed that the income level is not associated with gender differences in socioeconomic indicators, such as infant mortality and school enrollment, while income level is strongly correlated with the absolute levels of socioeconomic indicators. Their results suggested that anti-female bias in South Asia cannot be caused by poverty and low levels of income.

However, these empirical studies are mostly from a cross-country analysis based on small samples observed at a single point in time. Therefore, previous studies could not directly analyze the changes in the level of gender bias over time, and could possibly lead to misleading results. For instance, when a sample size is small, empirical results may be extremely sensitive to the choice of data sets, the

[11] According to Sen's study of "missing women" and population statistics from the United Nations, the Middle East and North Africa region is well known to have severe anti-female biases similar to South Asia.

choice of variables, or the quality of data sets. Also, it is not clear whether the variation of gender bias is explained by variation across countries or by variation over time.[12]

By and large, existing studies have highlighted severe gender inequalities in South Asia, focusing on the regional characteristics attributed to strong preferences for male offspring due to cultural and traditional customs. It is true that South Asia is the region with the most serious anti-female gender bias in child health. However, it is still unclear whether severe anti-female bias in child health in South Asia is only attributable to cultural or traditional factors, or whether the degree of gender bias varies with economic conditions and the development of the society.

The empirical strategy employed in this paper differs from existing literature in two aspects. First, this study empirically examines the regional differences in gender discrimination, taking into account time-series variations. Furthermore, this paper tests whether economic factors (income growth) are responsible for gender bias in child mortality, even in South Asia.

To summarize the literature review, we can find regional differences in gender bias, especially between South Asia and Sub-Saharan Africa, although there are still too few empirical studies in other regions to bring them into comparison. There is severe anti-female discrimination in the health condition of children in South Asia; in contrast, no such anti-female gender discrimination exists in Sub-Saharan Africa. It is worth considering this regional contrast between South Asia and Sub-Saharan Africa, since both regions are impoverished.

[12] In other words, unobserved time-invariant, country-specific effects are not controlled.

3. DESCRIPTIVE TRENDS IN GENDER BIAS IN CHILD MORTALITY

Regional Characteristics of Gender Bias

Evidence from Macro Statistics: Gender Bias in Childhood Mortality Rates

Infant mortality, defined here as children who die at 12 months of age or less, and under-five mortality, defined as the death at 60 months of age or less, are both recognized as one of the most useful social indicators of child health. The infant mortality rate is an indicator directly influenced by biological or environmental factors, including mother's health, prenatal care, access to professional delivery help, and sanitary conditions. In contrast, the under-five mortality rate is influenced by socioeconomic factors and parents' behaviors, such as intrahousehold allocation of food intake or availability of health care among children.[13] Although the under-five mortality rate is more relevant than the infant mortality rate for examining gender bias in child heath, it is not an ideal indicator, since under-five mortality includes infant mortality. With respect to the research interest here, the childhood mortality rate, defined as children who die between the age of 12 months and 60 months, is the most adequate macro (aggregated) indicator to examine the unequal distribution of food and health-care access by the sex of children.[14]

Gender differentials in infant and childhood mortality rates are shown in Figure 1 (early 1990s) and Figure 2 (1998). The indicator used here is the female-male ratio of mortality rate, defined as a female mortality rate divided by that of the male. For instance, if the female mortality rate is 60 and the male mortality rate is 50, then the female-male ratio of mortality is 1.2. Therefore, the ratio greater than 1.0 means the excess female mortality as compared to male mortality. Data on infant and childhood mortality rates by sex are extracted from the Demographic and Health Survey (DHS) and U.S. Bureau of the Census, International Database.[15]

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[13] It should be noted that causes of child mortality are mainly divided into "resistance" to disease and "exposure" to infectious agents. On the one hand, economic growth probably helps to enhance the power of resistance to disease because it is affected by nutrition intake and health inputs. On the other hand, the degree of exposure to infectious disease usually increases with economic development, especially with expansion of migration and sphere of activities. This paper focuses on the effect of the resistance factor on child health because it is more related to intrahousehold resource allocation outcomes.

[14] This does not mean that the childhood mortality rate is the best indicator to evaluate gender bias in mortality. At least among three aggregated indicators—infant, childhood, and under-five mortality rates—which are easily found in international statistics such as the United Nations Demographic Yearbook, the childhood mortality rate is the most adequate indicator to examine gender differences in child mortality caused by unequal distribution of nutrition and health inputs. As mentioned in the next subsection, from an epidemiological point of view, the childhood mortality rate is still not an ideal indicator, since the causes of death during the first week to a month are different from those that occur later. Using the data of birth and death histories, we can calculate better age-specific mortality rates, such as the mortality between one and 18 months.

[15] See these websites: DHS http://www.measuredhs.com/; U.S. Bureau of the Census; International Data Base: http://www.census.gov.ipc/www/.

Figure 1. Gender bias in childhood mortality rate (in the early 1990s)

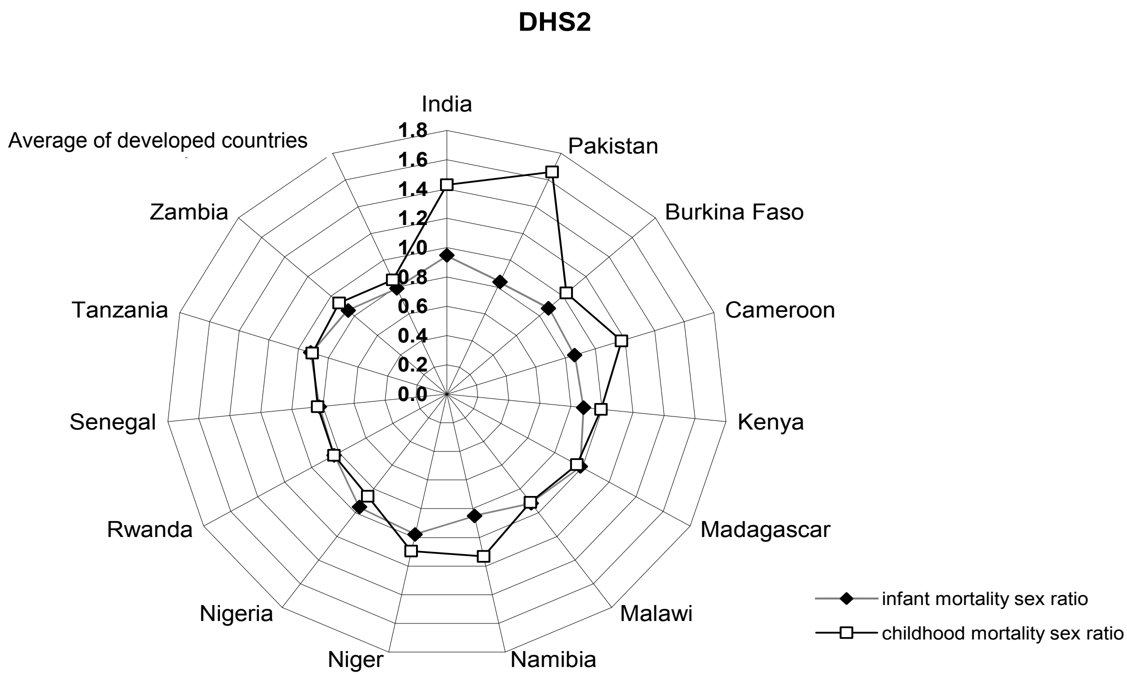
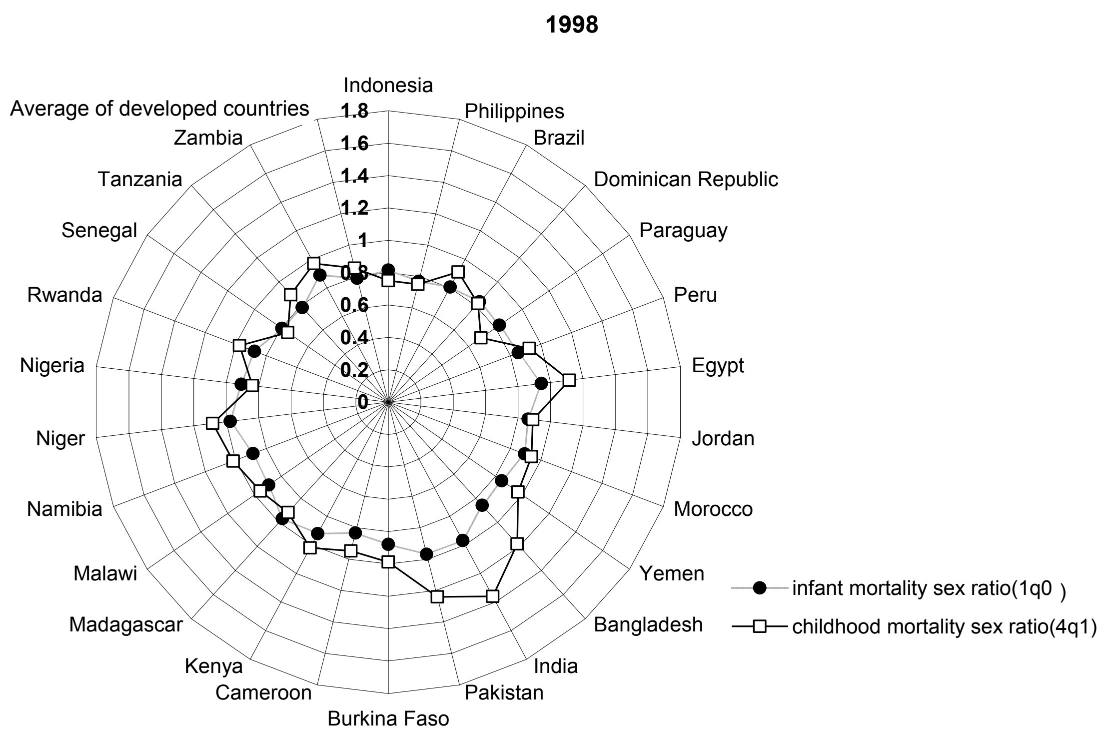


Figure 2. Gender bias in childhood mortality rate (1998)



Both Figures 1 and 2 show that the female-male ratio of infant mortality is less than 1 in most countries; indeed, it is fairly close to the averages in developed countries, which conform to the approximate value derived from biology.[16] In contrast, the sex ratio of childhood mortality is different among countries. Excess female childhood mortality is found in some countries, in particular, India, Pakistan, and Egypt. Differences between the female-male ratio of infant mortality and that of childhood mortality in South Asia and the Middle East and North Africa indicate the existence of unequal distribution of food and health inputs against females in these regions.

In Sub-Saharan African countries, meanwhile, there are few differences in infant and childhood mortality by the sex of the children. The sex ratio of infant mortality as well as the sex ratio of childhood mortality are approximately equal to averages in developed countries, suggesting no gender discrimination in terms of child mortality in Sub-Saharan Africa. In short, there is severe anti-female discrimination in childhood mortality in South Asia, in contrast to gender equality of child mortality in Sub-Saharan Africa. These results are consistent with the evidence from previous studies.

The comparison between the two periods (Figures 1 and 2) shows that the degree of anti-girl bias in childhood mortality seems to have declined from the early 1990s to 1998. Since per capita income/living standards increased during this period in many of the developing countries, such a result suggests that the extent of gender bias may be associated with the income level. In other words, it is possible that the anti-female difference in childhood mortality has been on a gradual decline as per capita income increases.

Mortality Rates of Children Calculated by Retrospective Birth and Death Histories from DHS

By the simple comparison of gender bias in the childhood mortality rate (probability of death between 12 and 60 months) using the aggregated mortality rate from macro statistics, we found that there is strong anti-female bias in child mortality in South Asia, in contrast to few such gender differences in Sub-Saharan Africa. However, from an epidemiological point of view, the childhood mortality rate is not an ideal indicator to evaluate gender bias in intrahousehold distribution of food and health inputs.

For instance, the neonatal mortality rate, which is defined as the probability of death within four weeks of birth, is much higher than other mortality rates after the first month of life. Also, the cause of death is quite different. In general, neonatal mortality is significantly influenced by whether infants can build up their immune systems through breast feeding, which is directly related to the mother’s health and sanitary conditions. On the other hand, mortality of children between one and 18 months is influenced by food and nutritional intake and the availability of health inputs, for which gender bias in intrahousehold

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[16] Since boys have a biological disadvantage during the neonatal period, an adequate criterion of gender equality in the female-male ratio of childhood mortality is approximately 0.8.

resource allocation will be strongly felt. After the infant is 18 months old, she/he will be biologically strong enough to survive even in adverse conditions. Hence, even if gender discrimination in resource allocation exists, the effect will be much harder to detect.

Therefore, the regional trend in gender bias in child mortality needs to be scrutinized using a variety of definitions of age-specific mortality rates in addition to the childhood mortality rate. We create various age-specific mortality rates calculated by information gathered on retrospective birth and death histories of children. There are major advantages to compute mortality rates from the birth and death records of individuals. First, one can calculate various age-specific mortality rates, such as the mortality rate within four weeks of life (neonatal mortality) and the mortality rate between one and 18 months, while the aggregated statistics can only provide the infant mortality rate and the childhood mortality rate.

In addition, the definition and data sources of aggregated mortality rates reported in the secondary statistics are not documented properly in many cases. For instance, is the "infant mortality in 2000" calculated using data from those who were born in 1999? Or, is it based on the mortality rate of children who were born between 1990 and 1999? If the calculation method differs between the data source, trends in the aggregated mortality rate and its gender bias may be incorrect. Therefore, we need to construct reliable data using a consistent calculation method based on individual records.

For all 55 countries that conducted more than one DHS survey, we calculate various age-specific mortality rates by the birth year of children, using retrospective birth and death histories from each DHS survey (112 surveys).[17] The following age-specific child mortality rates are calculated: infant mortality, childhood mortality, neonatal mortality, the mortality rate between one and 18 months, the mortality rate between 18 and 36 months, the mortality rate between one and 12 months, the mortality rate between 36 and 60 months, and the mortality rate between one and 60 months. To avoid problems with censored data, information on all children born within 60 months of the survey is discarded. Children who were born before 1965 are also discarded. Paxson and Schady (2004), which computes infant mortality rates in Peru using retrospective birth and death histories from the 1986, 1992, 1996, and 2000 Peru Demographic and Health Surveys (DHS), found mortality rates calculated from different DHS surveys are similar. Therefore, in the case of countries that conducted more than two surveys, we aggregate surveys administered on different years in a same country in order to increase the number of observations.

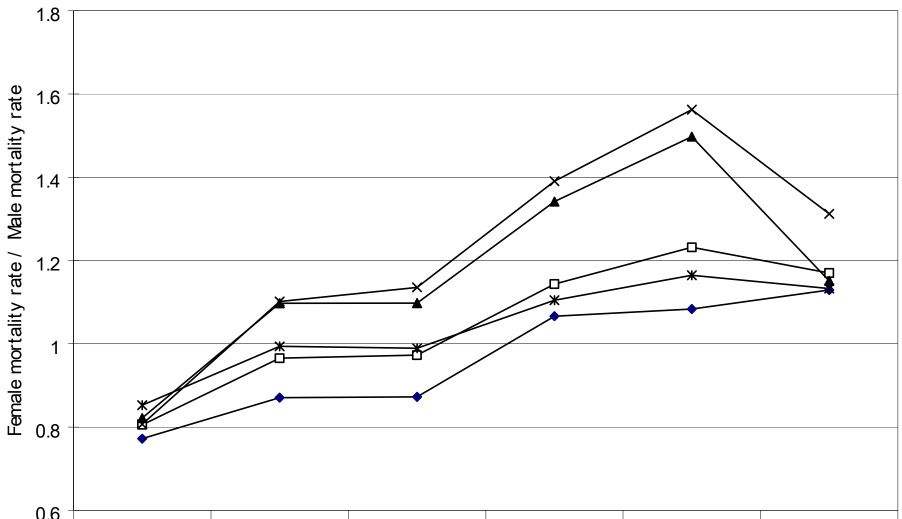
Figure 3 shows the trends in gender bias in various age-specific mortality rates by region.[18] The female-male ratio of neonatal mortality is approximately 0.8 in all regions, that is, no gender difference in neonatal mortality exists. However, it is apparent that female-male ratios become significantly higher in

[17] The regional breakdown of the number of countries in East and Southeast Asia is 3, 14 in Latin America, 5 in the Middle East and North Africa, 5 in South Asia, and 28 in Sub-Saharan Africa.

[18] We calculate age-specific mortality rates for each year at birth. Hence, the female-male mortality rates in Figure 3 are the average of all birth-cohort.

the case of mortality after the first month of life. In the Middle East and North Africa and in South Asia, the female-male mortality ratio between one and 18 months is more than 1; this means that girls are more likely to die than boys in this period.

Figure 3. Trends in female-male ratios in mortality rates of children, by regions



	q0-1	q2-12	q2-18	q19-24	q25-36	q37-60
East and Southeast Asia	0.77	0.87	0.87	1.07	1.08	1.13
Latin America	0.81	0.97	0.97	1.14	1.23	1.17
Middle East	0.82	1.10	1.10	1.34	1.50	1.15
South Asia	0.81	1.10	1.14	1.39	1.56	1.31
Sub-Saharan Africa	0.85	0.99	0.99	1.10	1.16	1.13

After 18 months, gender bias against girls continues to become more serious, although the absolute number of deaths is decreasing. Not only is the degree of gender bias increasing remarkably in the Middle East and North Africa and South Asia, but more interestingly, female-male mortality ratios are more than 1 in all regions, including Sub-Saharan Africa, where aggregated statistics indicate anti-female gender bias in childhood mortality rates does not exist.

The female-male mortality ratio peaks in the mortality rate between 24 and 36 months, after which gender bias in mortality decreases with the increasing age of children. This fact suggests that it may be hard to detect gender bias in mortality after 3 years old, even if gender inequality in resource allocation still remains.

In sum, using finer measures of age-specific information revealed the following new findings. First, no gender bias in mortality is present in the first four weeks after birth; then anti-female discrimination increases with the age of the children, reaching a peak at age 2 or 3 years, and then eventually decreasing. Second, such a tendency is seen in every region to greater or lesser degrees. Third, girls in South Asia and in the Middle East and North Africa face the most serious discrimination in mortality in the world.

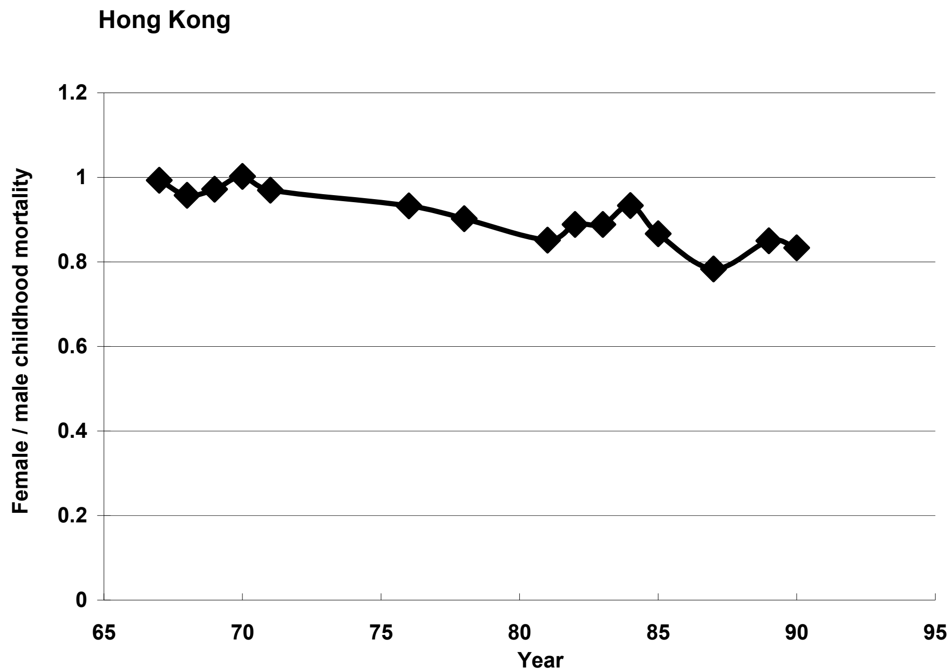
Changes in Gender Bias in Mortality of Children

Since little is known about the changes in gender bias in mortality over time, this section presents the trend in gender bias in child mortality, before considering the effect of income growth on gender bias.

Figure 4 shows the long-term trend in sex ratio of childhood mortality using the aggregated statistics. The sequential line graphs used here are three-period moving average curves. Although the long-term trends are available in only a handful of countries due to data constraints, we find the decreasing trend in anti-female bias in childhood mortality in many countries. In Korea, Hong Kong, and Malaysia, which grew rapidly for a sustained period of time, the anti-female discrimination in childhood mortality declined over time. In particular, while Korea is considered as a country where parents have a strong preference for sons, anti-female gender biases in childhood mortality have declined to approximately equal to the average value of developed countries by the 1980s. Similar trends are seen in other countries. It is clear that the degree of gender bias can change over time. In most countries, gender bias has been declining.

Since the aggregated statistics do not provide a long-term trend in childhood mortality in Sub-Saharan Africa and South Asia, Figure 5 shows a five-year moving average of gender bias in various age-specific mortality rates calculated by individual birth and death information from the DHS in those regions. Trends are similar among South Asian countries. First, anti-female bias is the highest in the mortality rate between 18 and 36 months, followed by between 1 and 18 months and 12 and 60 months (childhood mortality rate). Second, it is not clear whether female-male ratios of age-specific mortality change (decrease) significantly over time; on the one hand, the anti-female bias increases in Nepal; on the other hand, the gender bias decreases in Pakistan. Third, however, in terms of the absolute level of male and female mortality differences, the gender differences tend to decline gradually. Such a decline in the absolute gender differences in childhood mortality may be because of income growth during the period.

Figure 4. Trends in gender bias in childhood mortality over time



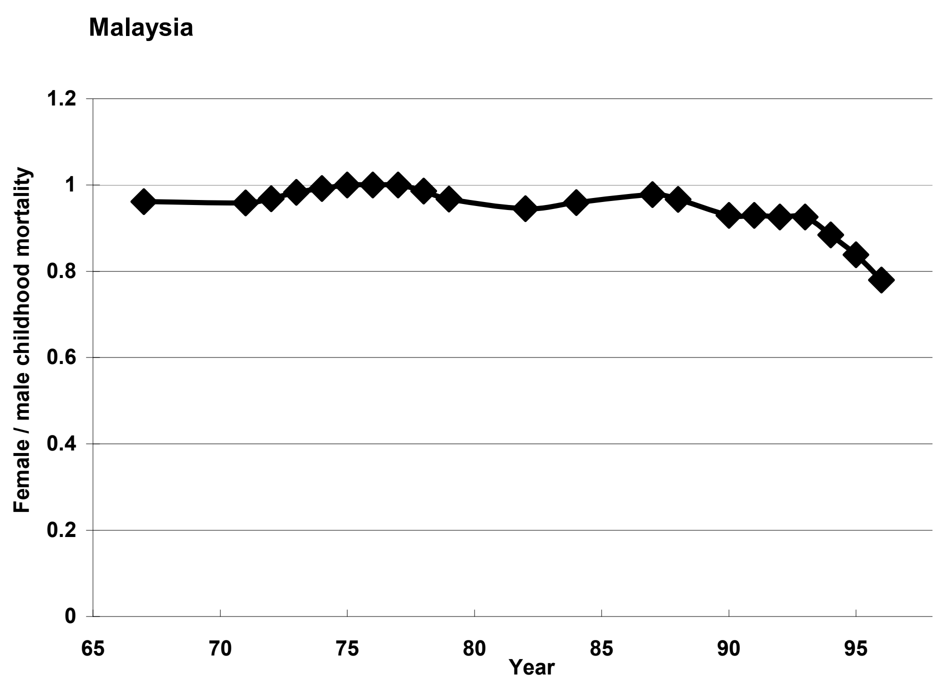
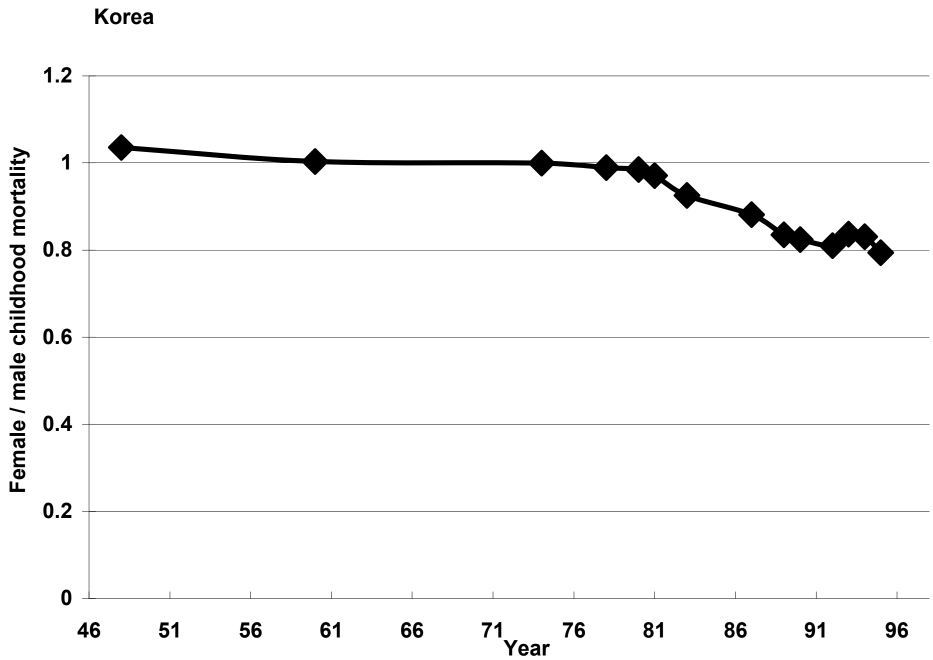


Figure 4. Continued



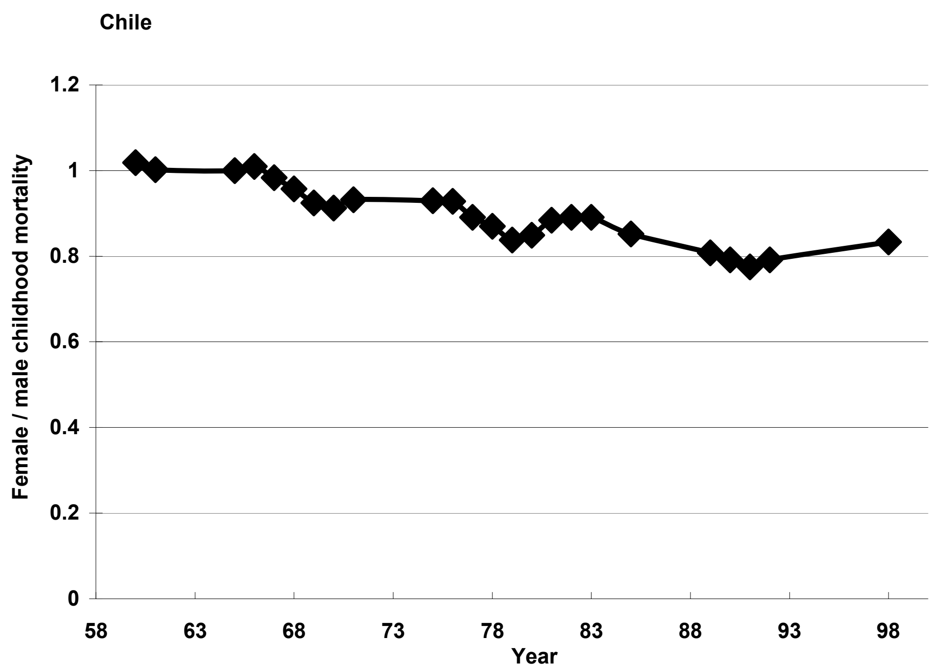
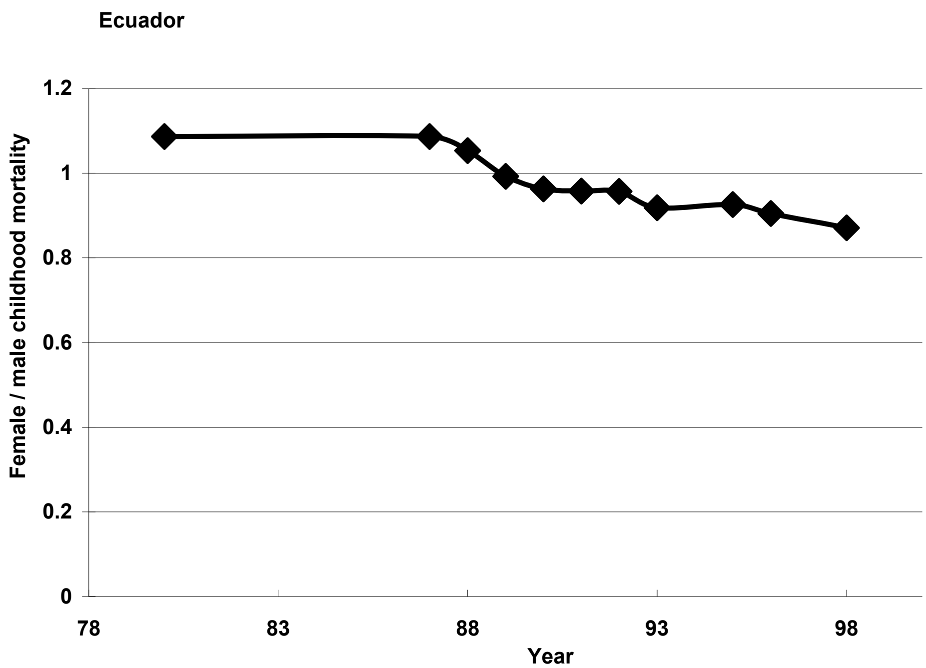


Figure 4. Continued



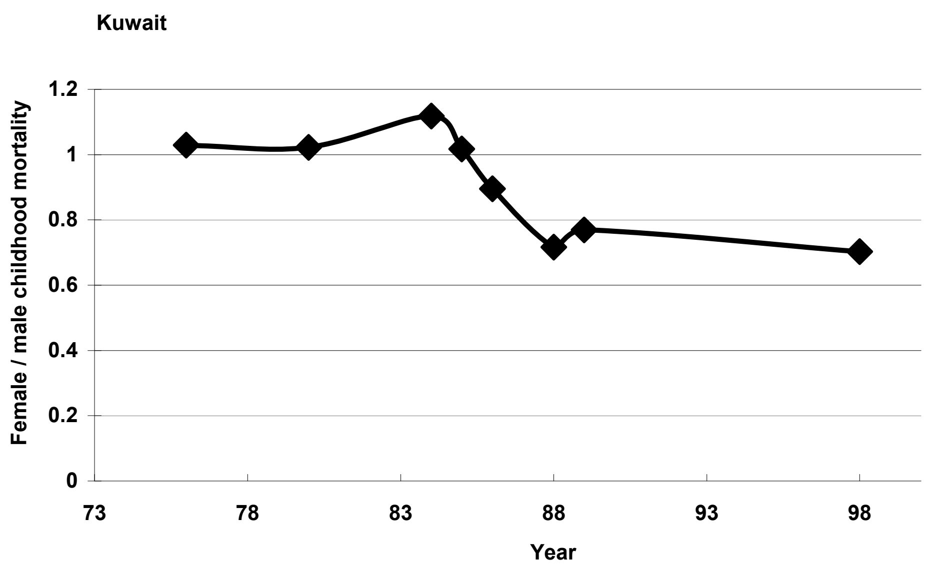
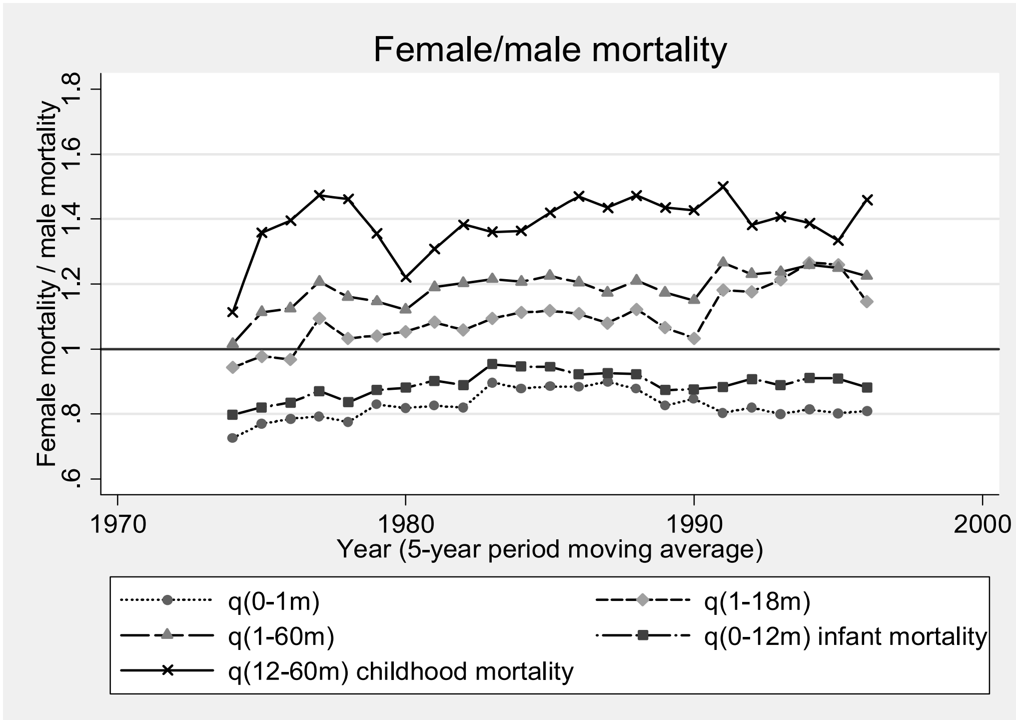


Figure 5. Trends in gender bias in various age-specific mortality rates

(a) Bangladesh

Female-male mortality ratios



Absolute gaps of female-male mortality

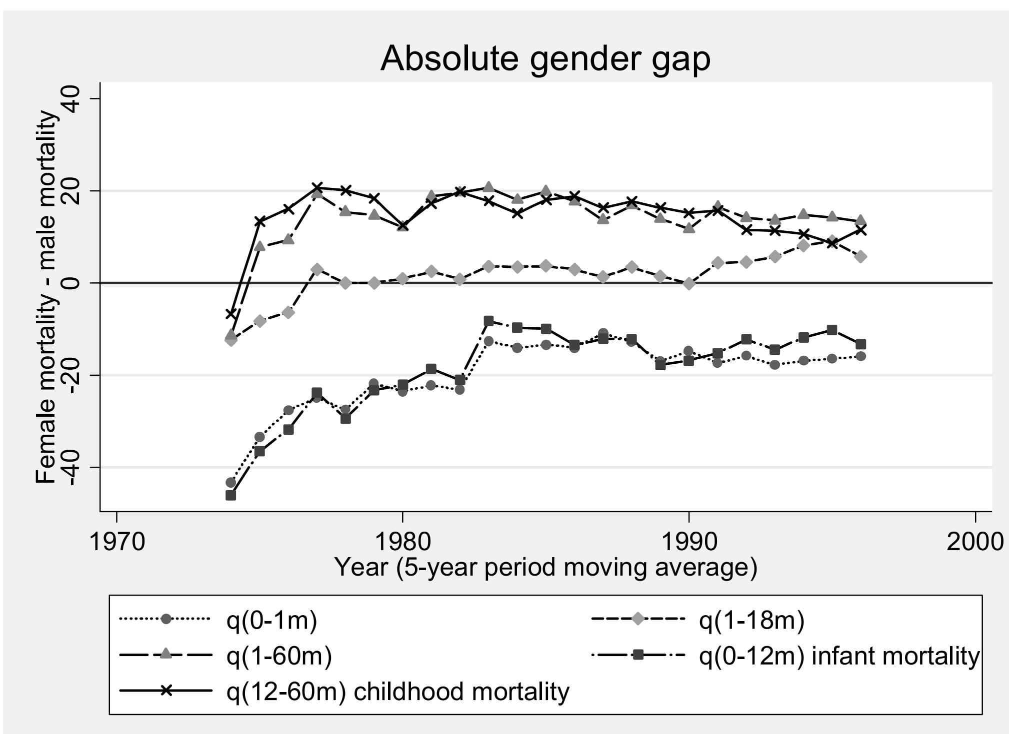
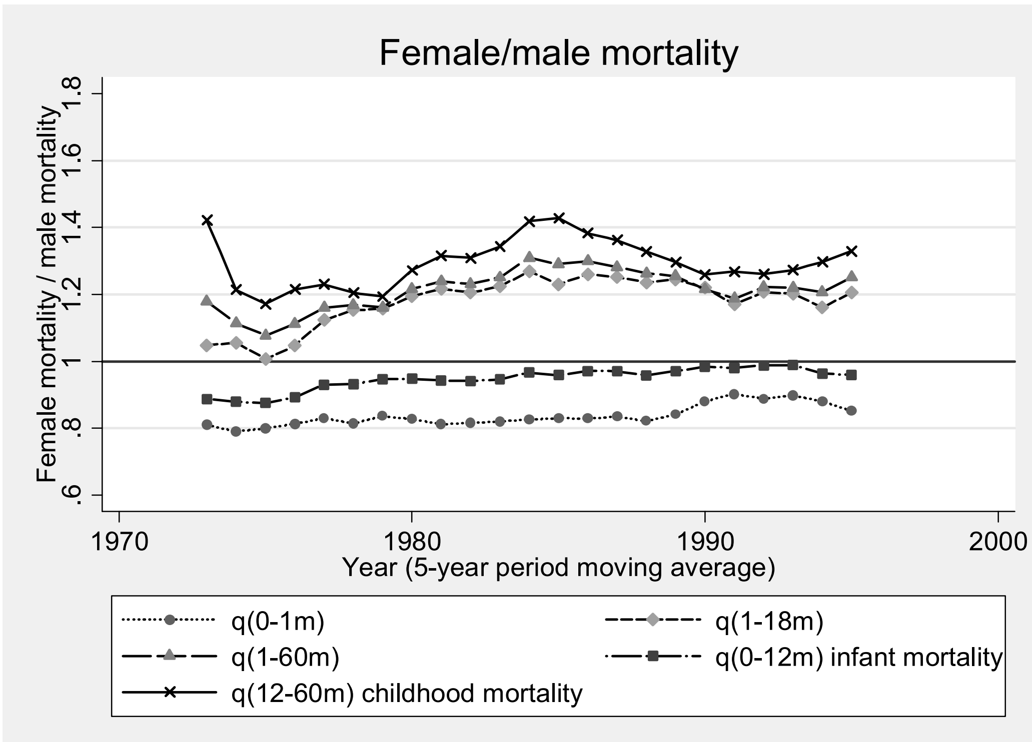


Figure 5. Continued

(b) India
Female-male mortality ratios



Absolute gaps of female-male mortality

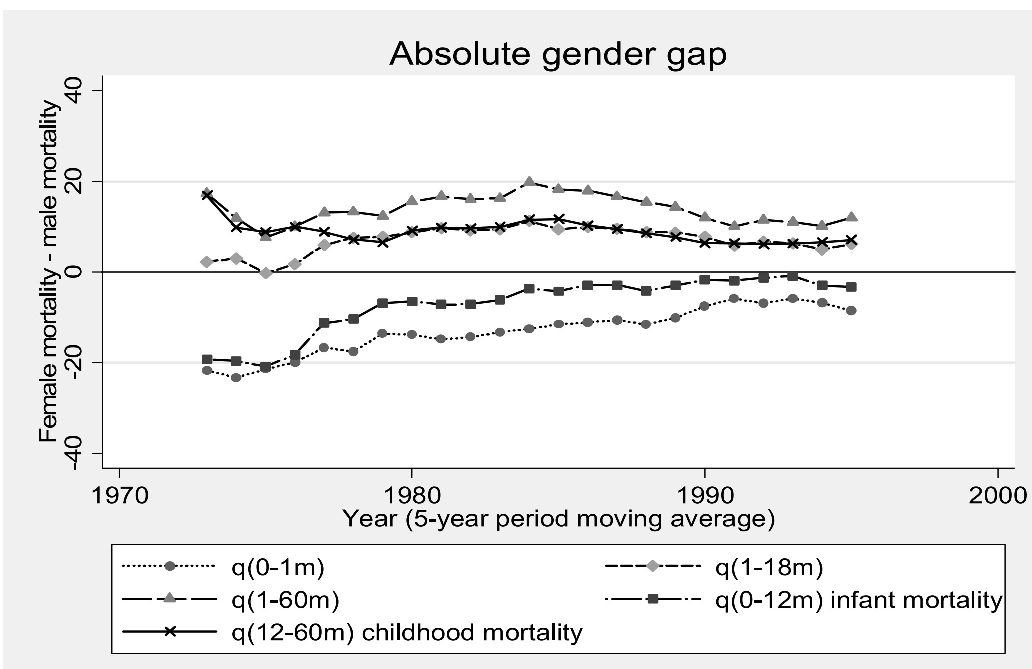
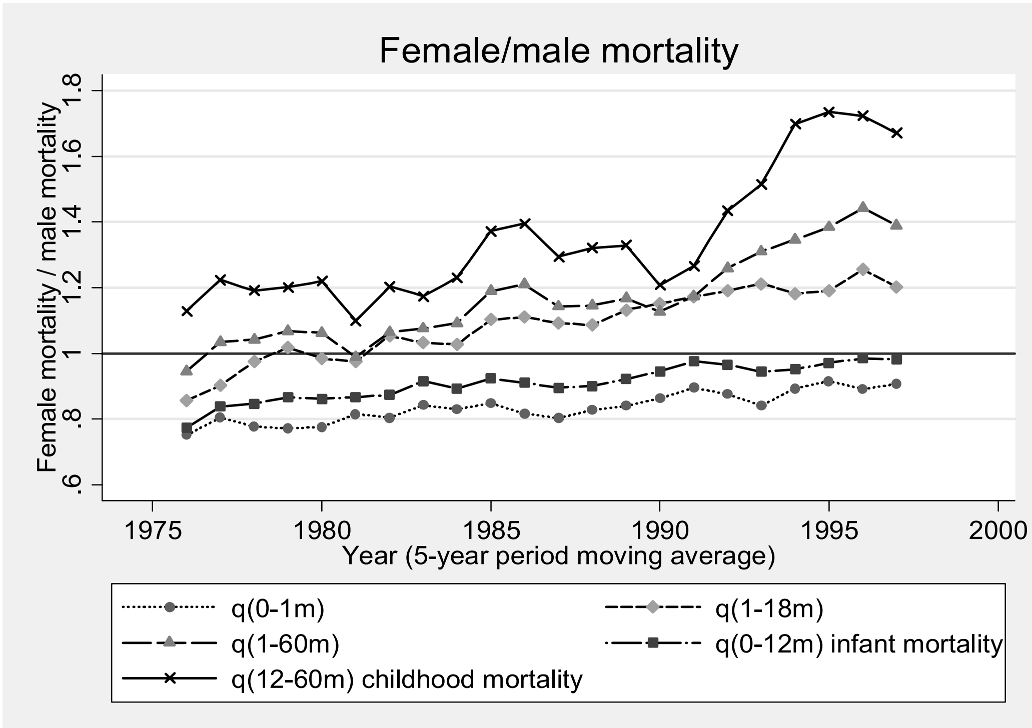


Figure 5. Continued

(c) Nepal
Female-male mortality ratios



Absolute gaps of female-male mortality

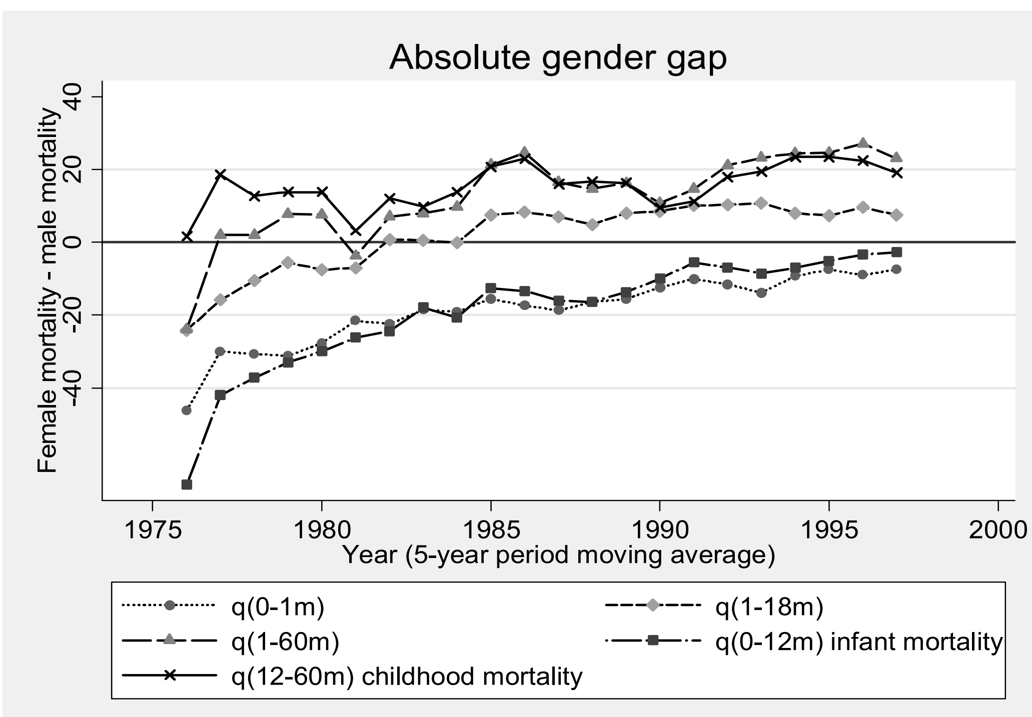
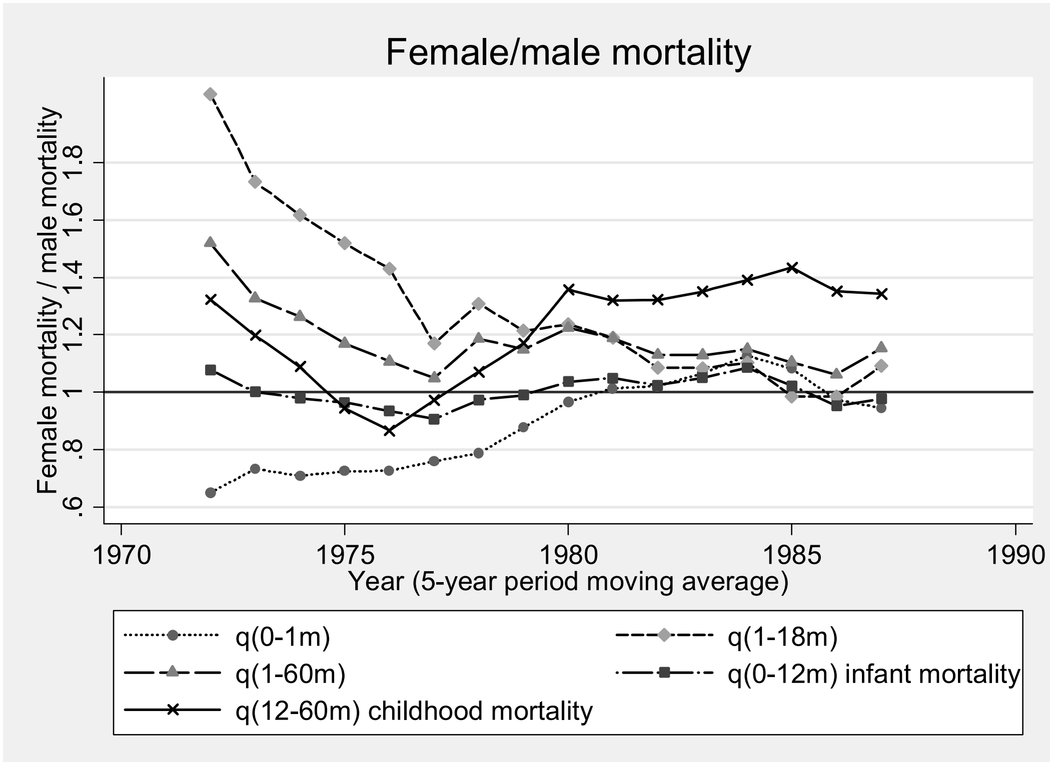


Figure 5 Continued

(d) Pakistan
Female-male mortality ratios



Absolute gaps of female-male mortality

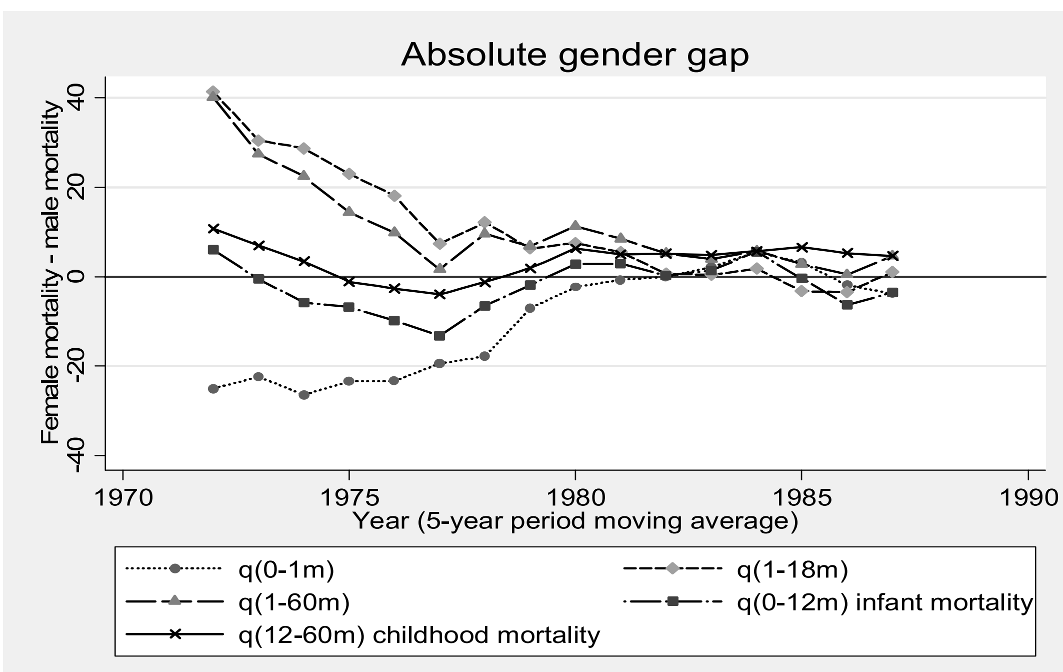
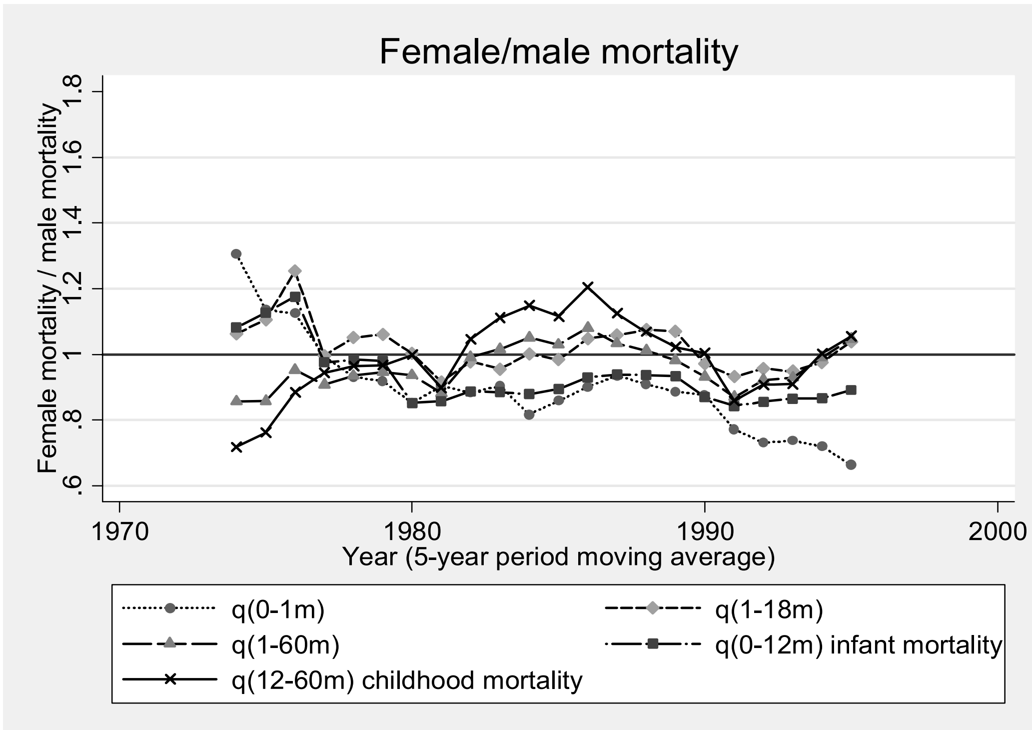


Figure 5 Continued

(e) Burkina Faso
Female-male mortality ratios



Absolute gaps of female-male mortality

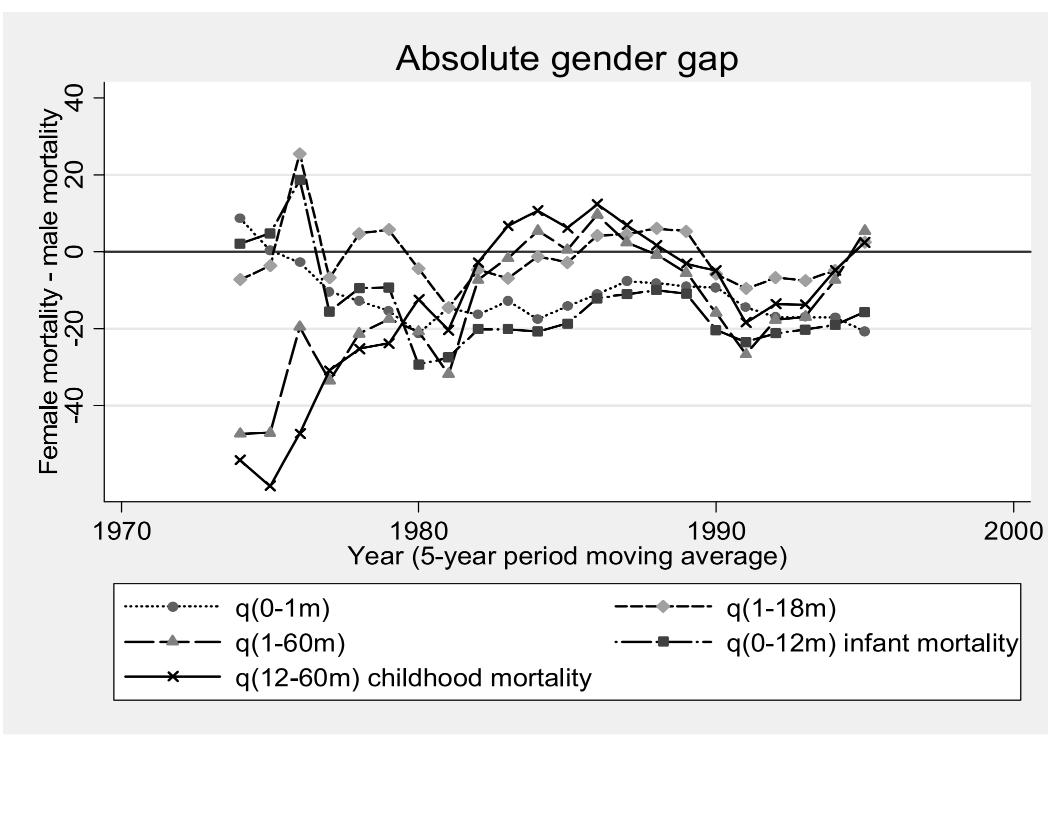
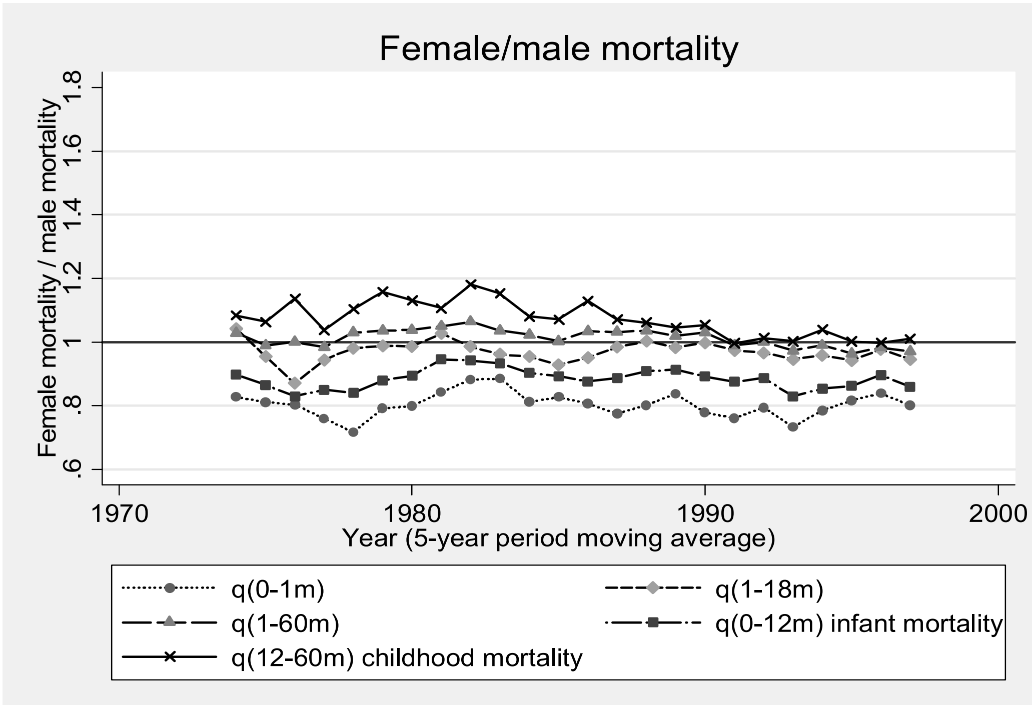


Figure 5 Continued

(f) Mali
Female-male mortality ratios



Absolute gaps of female-male mortality

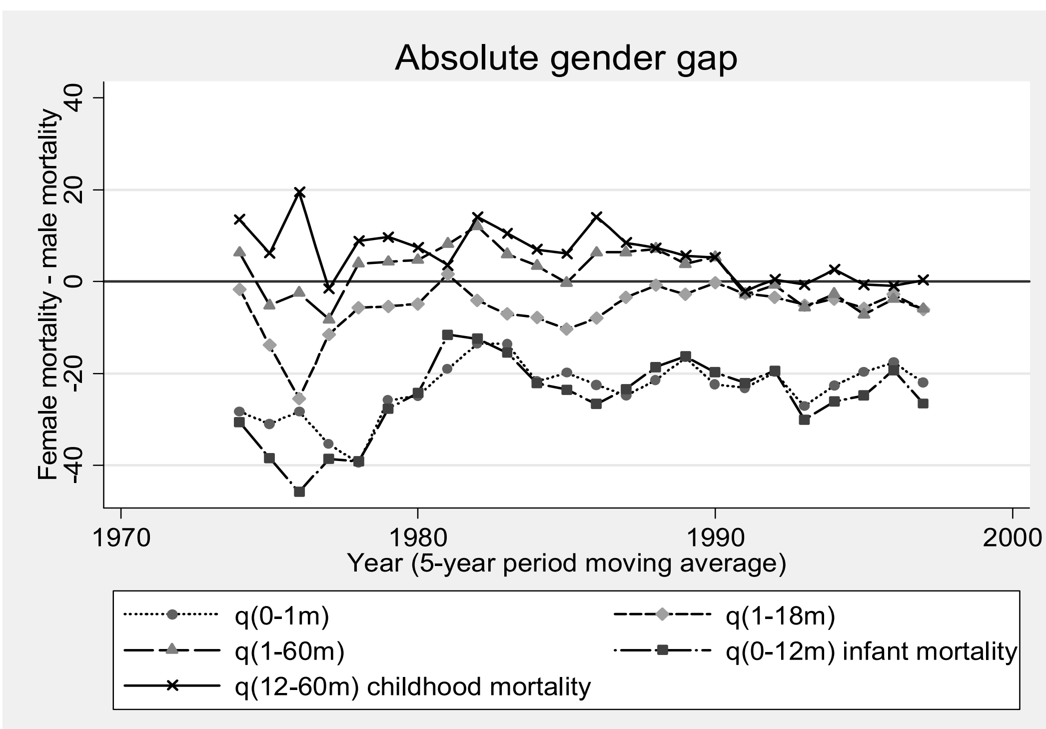
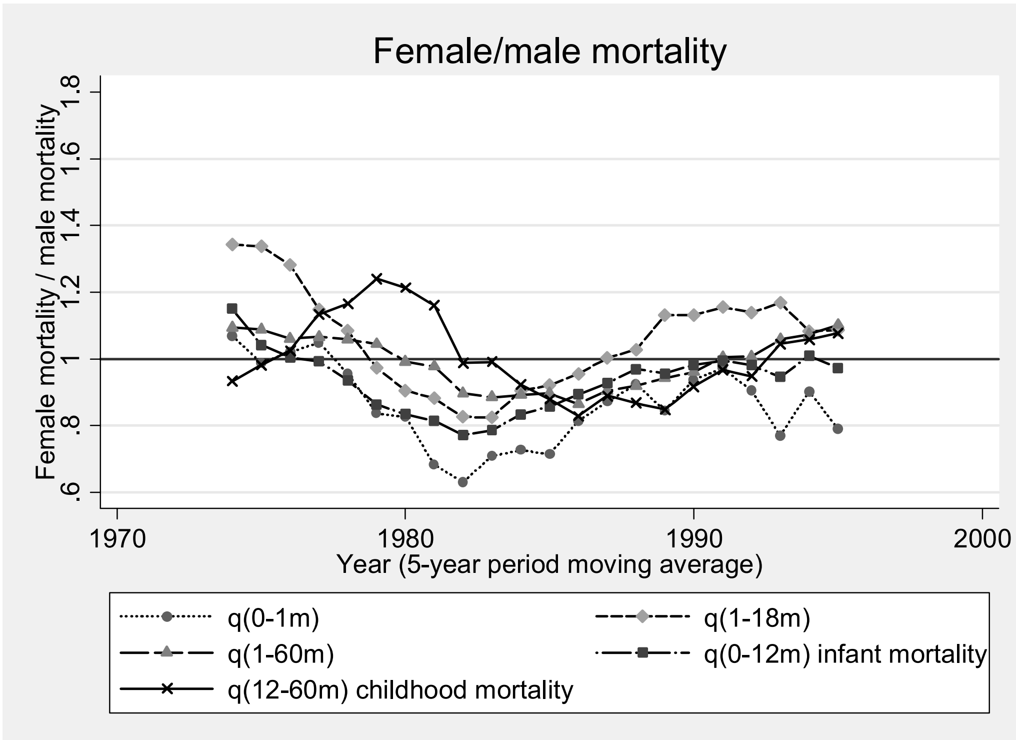


Figure 5 Continued

(g) Tanzania
Female-male mortality ratios



Absolute gaps of female-male mortality

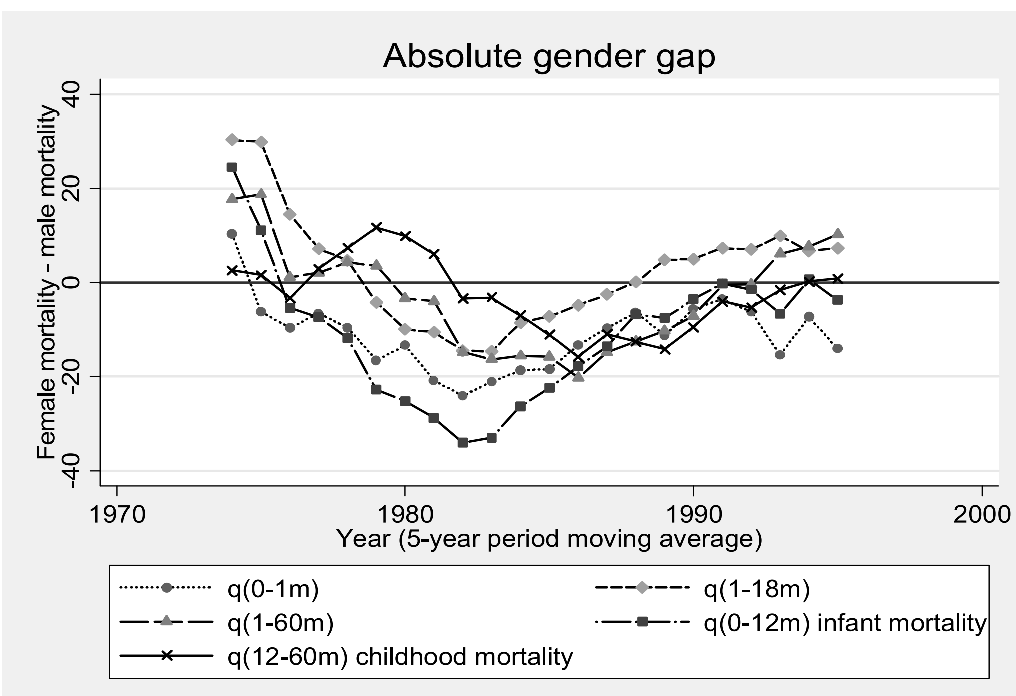
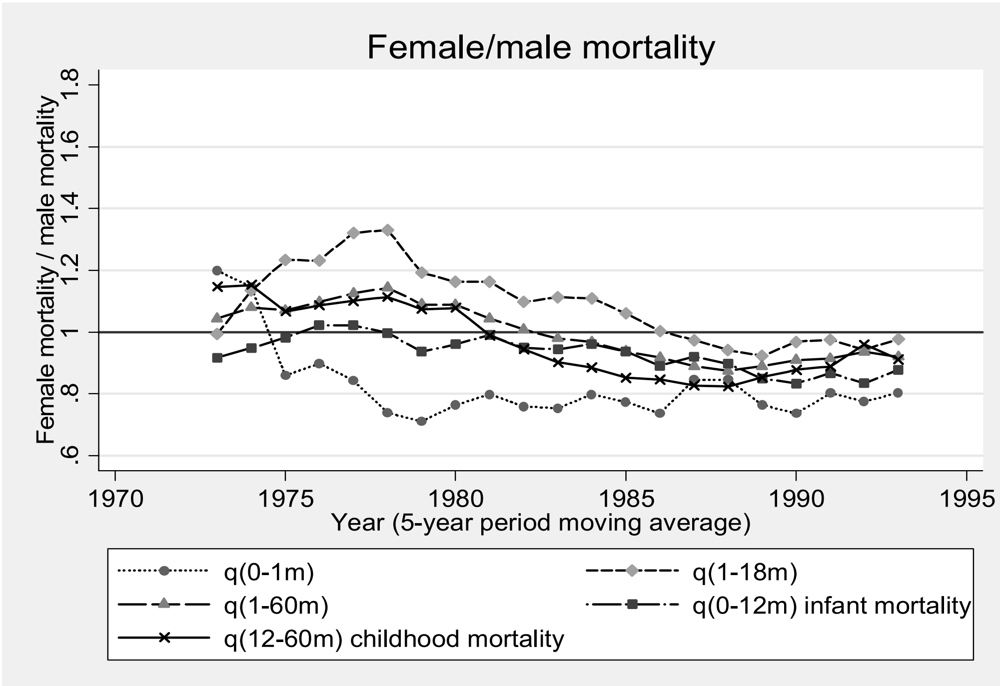
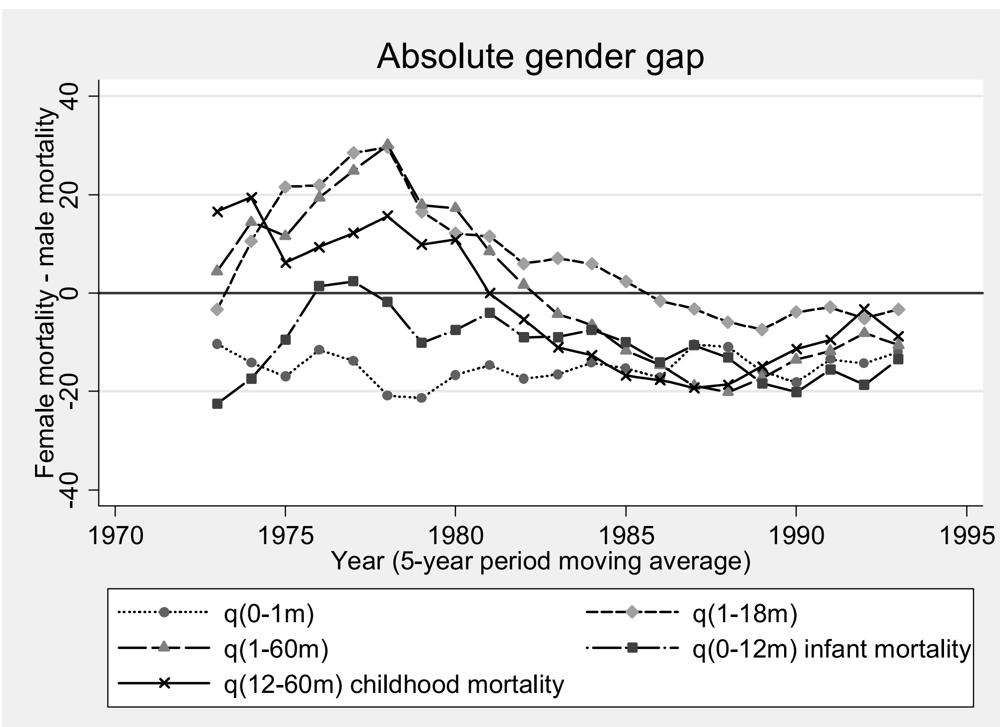


Figure 5 Continued

(h) Senegal
Female-male mortality ratios



Absolute gaps of female-male mortality



In contrast, in terms of changes in gender bias over time, trends are more heterogeneous among Sub-Saharan African countries. For instance, the degree of gender bias is almost constant in Mali. In Senegal, anti-female gender bias in mortality decreases gradually over time. In Burkina Faso and Tanzania, there is no clear trend. However, the single clearest feature in Sub-Saharan Africa is that the range of gender bias fluctuation is relatively less than in South Asia. Consequently, there are few differences in the absolute level of the mortality rate by sex in Sub-Saharan Africa. Since most Sub-Saharan African countries were afflicted with severe economic stagnation in that period, evidence that the degree of gender bias remained constant may suggest no gender bias in Sub-Saharan Africa despite a negative economic growth. These results suggest that the correlation between gender bias and income level may differ from other regions.

Table 2 summarizes the average female-male ratios of various age-specific mortality rates from the DHS, by region, in the 1970s, 1980s, and 1990s. There is no clear evidence that gender bias decreases over time, although anti-girls bias decreases gradually in Southeast Asia and Latin America. While the initial level of anti-girls bias is much smaller in Sub-Saharan Africa than in other regions, we find a similar tendency toward gender equality in this region. In contrast, the degree of anti-female bias seems to worsen slowly over time in South Asia and the Middle East and North Africa. We did not find concrete evidence of a decreasing in gender bias in those regions. However, whether the degree of gender bias can be changed with economic condition or not is open to discussion. This point will be examined empirically in the following sections.

Table 2. Changes in female-male ratios of mortality rates of children over time, by geographical region

Age-specific mortality	Neonatal mortality	Between 1 and 18 months	Between 18 and 36 months	Between 36 and 60 months	Between 1 and 12 months	Between 1 and 60 months	Infant mortality	Childhood mortality
East and Southeast Asia								
1970s	0.777	0.912	1.287	1.130	0.915	0.925	0.814	1.112
1980s	0.764	0.871	0.948	1.047	0.879	0.926	0.797	0.980
1990s	0.778	0.796	0.914	1.262	0.769	0.848	0.772	1.037
Latin America								
1970s	0.737	0.981	1.257	1.179	0.968	1.012	0.818	1.168
1980s	0.849	0.994	1.195	1.160	0.984	1.007	0.912	1.050
1990s	0.847	0.928	0.959	1.170	0.934	0.939	0.863	1.048
Middle East								
1970s	0.807	1.056	1.271	1.027	1.046	1.050	0.916	1.108
1980s	0.813	1.096	1.346	1.193	1.094	1.087	0.941	1.189
1990s	0.874	1.198	1.065	1.354	1.220	1.177	0.992	1.177
South Asia								
1970s	0.768	1.129	1.224	1.384	1.099	1.244	0.852	1.300
1980s	0.826	1.091	1.328	1.275	1.038	1.155	0.894	1.356
1990s	0.840	1.213	1.650	1.258	1.203	1.278	0.946	1.399
Sub-Saharan Africa								
1970s	0.903	1.003	1.123	1.152	1.018	1.019	0.918	1.065
1980s	0.818	0.968	1.057	1.164	0.957	0.969	0.878	1.059
1990s	0.832	0.999	1.035	1.066	1.009	0.970	0.897	0.985

Source: Author's calculation from the DHS.

4. INCOME LEVEL AND GENDER BIAS

The pertinent question is whether economic growth has contributed to reduction in gender bias in child mortality. For instance, in East and Southeast Asia, the economies grew quite rapidly during the last three decades. With economic growth, income poverty has reduced significantly, and social indicators have also improved remarkably. However, there are very few studies on whether such growth and improvement in living standards led to a reduction in gender bias in child mortality.

While numerous studies have focused on gender differences in health outcomes among children, the relationship between the level of income and the degree of gender inequality is still controversial. The majority of previous studies showed that the degree of gender bias is not correlated with socioeconomic conditions, such as poverty and income level; rather, gender bias is determined by social norms and customs proper to each region (Das Gupta 1987; Filmer, King, and Pritchett 1998). In terms of child mortality, studies found little relationship between gender bias and income levels, although few studies use long time-series observations or cross-country panel data. Using household surveys, studies on food consumption and health inputs found that gender discrimination disappears as income increases (Behrman 1988a; Alderman and Gertler 1997).

This section examines the relationship between gender bias in childhood mortality and income levels, using all available cross-country panel data. The main purpose of this section is to examine the bivariate correlation between the extent of gender bias (the female-male ratio of childhood mortality rate) and per capita GNP by region. To do so, data are collected from various data sources, such as the Demographic Health Survey (DHS), the United Nations Demographic Yearbook (UNDY), the World Fertility Survey (WFS), and the U.S. Census Bureau International Data Base (IDB).[19] We prioritize, making the large sample size data sets only in cases in which childhood mortality rate is calculated using the same definition.[20] Due to data constraints, the number of available observations varies among the countries. The data on economic development being used here are GNP per capita from World Development Indicators by the World Bank.

This paper classified developing countries into five regions: Latin America, South Asia, Sub-Saharan Africa, North Africa and the Middle East, and East and Southeast Asia. This grouping is

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[19] The absolute value of childhood mortality rate by sex, such as 50 people (per 1,000 living children), it may be inadequate, because the data are gathered from various different data sources. However, the differences in source of data are probably not a serious problem, because the focus of this analysis is the gender bias in childhood mortality (the female-male sex ratio).

[20] Another data problem is that the sex ratio of childhood mortality is frequently equal to 1, especially in the case of a lower mortality rate. In particular, it is a frequent occurrence in the observations from the United Nations Population Yearbook, because these statistics indicate a number to one decimal place only. In this paper, the observations where the sex ratio of mortality is equal to 1 are excluded from regression analysis.

generally adopted by cross-country growth analyses. China and transition countries are excluded from the discussion due to the lack of availability of data.

Table 3 shows the OLS regression results. The dependent variable is the female-male ratio of childhood mortality rate (BIAS). The independent variable is the logarithmic of GNP per capita (lnGNP). Column 2 controls for country fixed effects. Column 3 includes regional dummy variables. The reference category is Latin America. To check for robustness, we use the PPP GNP per capita in Columns 4 and 5.

Table 3. Correlation between income level and gender bias in childhood mortality (OLS)

	Dependent variable: Male-female ratio of childhood mortality rate				
	lnGNP: current US$			lnGNP: PPP	
	(1)	(2)	(3)	(4)	(5)
lnGNP	-0.052	-0.065	-0.045	-0.063	-0.07
	(7.52)***	(6.39)***	(5.81)***	(5.97)***	(4.02)***
lnGNP^2					
South Asia * lnGNP					
Sub-Saharan Africa * lnGNP					
Middle East and North Africa * lnGNP					
East and Southeast Asia * lnGNP					
South Asia			0.216		
			(6.13)***		
Sub-Saharan Africa			-0.006		
			(0.31)		
Middle East and North Africa			0.056		
			(2.27)**		
East and Southeast Asia			-0.03		
			(1.37)		
Constant	1.32	1.406	1.26	1.447	1.503
	(27.53)***	(20.24)***	(22.28)***	(17.62)***	(11.12)***
Observations	436	436	436	313	313
Country fixed effect	No	Yes	No	No	Yes
R-squared	0.12	0.5	0.21	0.1	0.61

Notes: The reference group of regional dummy is Latin America. Absolute value of t statistics is in parentheses. * significant at 10 percent; ** significant at 5 percent; *** significant at 1 percent.

The coefficient estimates on lnGNP are negative and significant in all specifications, suggesting a negative correlation between the extent of anti-female bias in childhood mortality and income levels.[21] This finding is robust to country fixed effects (Column 2). We also found a similar result using the PPP GNP per capita (Columns 4 and 5).

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[21] To test the non-linearity effect of GNP on gender bias, we examined a specification including a square term of GNP, but the coefficient is insignificant.

The coefficients on dummy variables for South Asia and in the Middle East and North Africa are significant and positive; in particular, the coefficient estimate on South Asia is much larger (Column 3). This result shows that the extent of anti-female bias in childhood mortality in South Asia (and the Middle East and North Africa) is much more severe than that in Latin America and other regions. This result is consistent with the evidence from previous studies and descriptive data in Sections 2 and 3.

In sum, this section examined the relationship between income levels and gender bias in child mortality using an expanded cross-country data set. We found negative correlation between income levels and gender bias in developing countries, even in the regions with deepening anti-female discrimination, such as South Asia and the Middle East and North Africa.

5. HOW INCOME AFFECTS THE CHANGE IN GENDER BIAS

The next question is how the degree of gender bias in child mortality has changed with income growth. One possible hypothesis is that economic growth has a positive effect on the alleviation of gender bias in child mortality, because mortality rates of children are related to health conditions of children that are influenced by food intake and health inputs. Income levels and the fluctuation of income have a direct influence on food- and health-related consumption among household members.

As mentioned in Section 3, the extent of gender bias in mortality could change over time. However, only a few studies have focused on the fluctuation of gender bias in the same country. In addition, we need to compare countries at similar socioeconomic levels to evaluate whether the degree of gender bias is attributed to region-specific fixed factors, such as religious and traditional norms rather than income growth. For example, a current level of gender bias in Sub-Saharan Africa or South Asia needs to be compared to the extent of the gender bias at the pre-economic development period in Southeast Asia, which has experienced rapid economic growth during the last few decades. Consequently, this section examines how income growth is associated with the change in the degree of gender bias in childhood mortality. In order to eliminate the existence of country-specific fixed effects, we employ the first-difference specification, using data from the 81 countries for which there are at least two observations.

The dependent variable, $\Delta BIAS_{it}$, is the difference in the female-male ratio of childhood mortality rates between the value in year t and previous year $t - r$ of a country i ($BIAS_{it} - BIAS_{it-r}$).[22] Thus, the value of $\Delta BIAS_{it}$ is negative if the anti-female bias in child mortality decreases. The explanatory variable is the first difference of the logarithm of GNP per capita ($\Delta \ln GNP_{it}$). Since initial conditions of income and gender inequality of the country are important factors in the change in gender bias, regression models add lagged values of the logarithm of GNP per capita ($\ln GNP_{it-r}$) and the female-male sex ratio of childhood mortality rate ($BIAS_{it-r}$). If it is hard to reduce the gender bias in low income countries, the sign of the coefficient on $\ln GNP_{it-r}$ would be negative. Likewise, if it is easy to reduce the gender bias in a gender-equal society, we would expect a positive coefficient on $BIAS_{it-r}$.

The basic model is

$$\Delta BIAS_{it} = \alpha_0 + \alpha_1 \Delta \ln GNP_{it} + \alpha_2 BIAS_{it-r} + \alpha_3 \ln GNP_{it-r} + u_{it}.$$

In addition to the basic model, we employ specifications to control for country-fixed effects to verify the robustness. We estimate a specification including all explanatory variables and region dummies

[22] Because the data set is an incomplete panel, time intervals of the observations are different among each country.

interacted with each of the explanatory variables. To test the nonlinearity of economic impact on gender bias, we add a square term of logarithm GNP per capita.

The results are presented in Table 4. The coefficient on $\Delta \ln GNP_{it}$ is significant and negative in all specifications, suggesting that an increase in GNP per capita possibly reduces the anti-female bias in childhood mortality. Likewise, the coefficient estimates on initial conditions of income and gender inequality are also significant and negative. Higher income countries are more likely to be able to reduce the gender bias in childhood mortality with economic growth than low-income countries. The positive effect of economic growth on the reduction of anti-girls bias in mortality is larger in a country with severe initial anti-girls discrimination than a gender equal country. The impact of income growth on gender bias is not linear; the coefficient estimate on the square term of income growth is significant and positive (columns 3 to 5). These findings are robust to unobservable country fixed effects (columns 2 and 4).

Regional differences in economic impact on gender bias are interesting. The interactions of $\Delta \ln GNP$ both with Sub-Saharan Africa and with East and Southeast Asia are positive and significant; in contrast, the interaction terms of $\Delta \ln GNP$ with South Asia and with Middle East and North Africa are insignificant. The result suggests the possibility that the effect of income growth is different between Sub-Saharan Africa (and East and Southeast Asia) and other regions. Such a regional difference is shown in the quadratic specification (column 6). Regarding the initial condition of gender inequality, the coefficients on interactions with the dummy variables for South Asia and the Middle East and North Africa are significant. With respect to the initial economic level, the interactions with Sub-Saharan Africa and East and Southeast Asia are positive, suggesting less correlation between initial level of income and changes in the degree of gender bias in those regions. The coefficients on constant region dummies show a significantly lower anti-girls bias in childhood mortality in Sub-Saharan Africa and East and Southeast Asia.

To assess whether the effects of economic growth and initial conditions on the reduction of gender bias in childhood mortality are different among regions, Table 5 tests the null hypothesis that all interaction terms with regional dummies are equal to zero. In terms of income growth, only the null hypothesis, the coefficients are equal in all regions except Sub-Saharan Africa, is not rejected. Similarly, the test result shows that the coefficients on (constant) dummy variables are the same, except for Sub-Saharan Africa. These results suggest that the tendency of the gender bias in childhood mortality and its correlation with income growth are different between Sub-Saharan Africa and the other regions. With respect to the initial conditions, the slopes of the coefficients on the initial economic level are different among each region. The coefficients on the initial level of gender discrimination are the same among regions implying that no regional differences exist.

Table 4. Effect of income growth on changes in gender bias (OLS)

	Dependent variable: Δ(male-female ratio of childhood mortality rate)					
	Linear specification			Quadratic specification		
	(1)	(2)	(3)	(4)	(5)	(6)
ΔlnGNP (α10)	-0.044	-0.077	-0.103	-0.11	-0.15	-0.321
	(2.18)**	(3.17)***	(3.14)***	(3.53)***	(4.06)***	(6.54)***
* South Asia (α11)			0.079			-0.204
			(0.61)			(0.47)
* Sub-Saharan Africa (α12)			0.151			0.373
			(2.54)**			(5.26)***
* Middle East and North Africa (α13)			-0.015			0.111
			(0.23)			(1.03)
* East and Southeast Asia (α14)			0.115			0.331
			(2.22)**			(3.33)***
ΔlnGNP^2 (α20)				0.06	0.067	0.186
				(2.76)***	(2.60)***	(5.77)***
* South Asia (α21)						0.457
						(0.86)
* Sub-Saharan Africa (α22)						-0.198
						(2.49)**
* Middle East and North Africa (α23)						-0.111
						(1.53)
* East and Southeast Asia (α24)						-0.185
						(3.17)***
PreBIAS (α30)	-0.685	-1.167	-0.869	-0.681	-1.144	-0.867
	(13.91)***	(18.01)***	(12.26)***	(13.94)***	(17.68)***	(12.79)***
* South Asia (α31)			0.394			0.41
			(1.99)**			(2.15)**
* Sub-Saharan Africa (α32)			0.179			0.177
			(1.25)			(1.30)
* Middle East and North Africa (α33)			0.227			0.244
			(1.53)			(1.72)*
* East and Southeast Asia (α34)			0.168			0.167
			(0.93)			(0.96)
PrelnGNP (α40)	-0.053	-0.088	-0.068	-0.051	-0.082	-0.074
	(6.67)***	(6.57)***	(4.14)***	(6.55)***	(6.14)***	(4.73)***
* South Asia (α41)			-0.15			-0.127
			(1.86)*			(1.62)
* Sub-Saharan Africa (α42)			0.048			0.054
			(1.83)*			(2.12)**
* Middle East and North Africa (α43)			-0.018			-0.012
			(0.67)			(0.45)
* East and Southeast Asia (α44)			0.038			0.045
			(1.61)			(1.95)*
South Asia (α51)			0.493			0.362
			(0.99)			(0.75)
Sub-Saharan Africa (α52)			-0.507			-0.56
			(2.13)**			(2.43)**
Middle East and North Africa (α53)			-0.014			-0.087
			(0.05)			(0.32)
East and Southeast Asia (α54)			-0.468			-0.527
			(1.71)*			(1.99)**

Table 4. Continued

	Dependent variable: Δ(male-female ratio of childhood mortality rate)					
	Linear specification			Quadratic specification		
	(1)	(2)	(3)	(4)	(5)	(6)
Constant (α50)	1.008	1.726	1.292	0.997	1.667	1.35
	(12.07)***	(13.72)***	(9.05)***	(12.03)***	(13.19)***	(9.85)***
Observations	355	355	355	355	355	355
Country fixed effect	No	Yes	No	No	Yes	No
R-squared	0.36	0.6	0.45	0.38	0.61	0.5

Notes: Number of observations: 355 (Sub-Saharan Africa, 87; East and Southeast Asia, 65;. Latin America, 140; Middle East and North Africa, 44; South Asia, 19). The reference group of regional dummy is Latin America. Absolute value of t statistics in parentheses. * significant at 10 percent; ** significant at 5 percent; *** significant at 1 percent.

Table 5. Tests on equality of coefficients on regional dummies

	H0	F-value
Linear specification (Table 4, column 3)		
①ΔlnGNP		
All regions	α11=α12=α13=α14=0	2.61**
Except Sub-Saharan Africa	α11=α13=α14=0	2.01
Except South Asia	α12=α13=α14=0	3.47**
Except Middle East and North Africa	α11=α12=α14=0	2.83**
Except East and Southeast Asia	α11=α12=α13=0	2.52*
③PreBIAS		
All regions	α31=α32=α33=α34=0	1.50
④PrelnGNP		
All regions	α41=α42=α43=α44=0	2.99**
Except Sub-Saharan Africa	α41=α43=α44=0	2.93**
Except South Asia	α42=α43=α44=0	2.50*
Except Middle East and North Africa	α41=α42=α44=0	3.01**
Except East and Southeast Asia	α41=α42=α43=0	3.15**
South Asia = Africa = 0	α41=α42=0	3.89**
South Asia = Middle East = 0	α41=α43=0	1.83
South Asia = East and Southeast Asia = 0	α41=α44=0	3.51**
Africa = Middle East = 0	α42=α43=0	2.74*
Africa = East and Southeast Asia = 0	α42=α44=0	2.08
Middle East = East and Southeast Asia = 0	α43=α44=0	2.38*
⑤Constant		
All regions	α51=α52=α53=α54=0	2.11*
Except Sub-Saharan Africa	α41=α43=α44=0	1.52
Except South Asia	α42=α43=α44=0	2.14*
Except Middle East and North Africa	α41=α42=α44=0	2.65**
Except East and Southeast Asia	α41=α42=α43=0	2.21*
Quadratic specification (Table 4, column 6)		
①ΔlnGNP		
All regions	α11=α12=α13=α14=0	7.96***
Except Sub-Saharan Africa	α11=α13=α14=0	3.86***
Except South Asia	α12=α13=α14=0	10.36***
Except Middle East and North Africa	α11=α12=α14=0	10.39***
Except East and Southeast Asia	α11=α12=α13=0	9.62***
South Asia = Africa = 0	α11=α12=0	14.23***
South Asia = Middle East = 0	α11=α13=0	0.67
South Asia = East and Southeast Asia = 0	α11=α14=0	5.74***
Africa = Middle East = 0	α12=α13=0	14.06***

Table 5. Continued

	H0	F-value
Africa = East and Southeast Asia = 0	$\alpha12=\alpha14=0$	15.15***
Middle East = East and Southeast Asia = 0	$\alpha13=\alpha14=0$	5.57***
②ΔlnGNP^2		
All regions	$\alpha21=\alpha22=\alpha23=\alpha24=0$	3.66***
Except Sub-Saharan Africa	$\alpha21=\alpha23=\alpha24=0$	3.86***
Except South Asia	$\alpha22=\alpha23=\alpha24=0$	4.55***
Except Middle East and North Africa	$\alpha21=\alpha22=\alpha24=0$	4.78***
Except East and Southeast Asia	$\alpha21=\alpha22=\alpha23=0$	2.76**
South Asia = Africa = 0	$\alpha21=\alpha22=0$	3.51**
South Asia = Middle East = 0	$\alpha21=\alpha23=0$	1.57
South Asia = East and Southeast Asia = 0	$\alpha21=\alpha24=0$	5.48***
Africa = Middle East = 0	$\alpha22=\alpha23=0$	3.69**
Africa = East and Southeast Asia = 0	$\alpha22=\alpha24=0$	6.67***
Middle East = East and Southeast Asia = 0	$\alpha23=\alpha24=0$	5.31***
③PreBIAS		
All regions	$\alpha_{31}=\alpha_{32}=\alpha_{33}=\alpha_{34}=0$	1.77
④PrelnGNP		
All regions	$\alpha_{41}=\alpha_{42}=\alpha_{43}=\alpha_{44}=0$	3.18**
Except Sub-Saharan Africa	$\alpha_{41}=\alpha_{43}=\alpha_{44}=0$	3.00**
Except South Asia	$\alpha_{42}=\alpha_{43}=\alpha_{44}=0$	3.01**
Except Middle East and North Africa	$\alpha_{41}=\alpha_{42}=\alpha_{44}=0$	3.31**
Except East and Southeast Asia	$\alpha_{41}=\alpha_{42}=\alpha_{43}=0$	3.17**
South Asia = Africa = 0	$\alpha_{41}=\alpha_{42}=0$	4.05**
South Asia = Middle East = 0	$\alpha_{41}=\alpha_{43}=0$	1.34
South Asia = East and Southeast Asia = 0	$\alpha_{41}=\alpha_{44}=0$	3.72**
Africa = Middle East = 0	$\alpha_{42}=\alpha_{43}=0$	3.15**
Africa = East and Southeast Asia = 0	$\alpha_{42}=\alpha_{44}=0$	2.93*
Middle East = East and Southeast Asia = 0	$\alpha_{43}=\alpha_{44}=0$	2.86*
⑤Constant		
All regions	$\alpha_{51}=\alpha_{52}=\alpha_{53}=\alpha_{54}=0$	2.42**
Except Sub-Saharan Africa	$\alpha_{51}=\alpha_{53}=\alpha_{54}=0$	1.69
Except South Asia	$\alpha_{52}=\alpha_{53}=\alpha_{54}=0$	2.69**
Except Middle East and North Africa	$\alpha_{51}=\alpha_{52}=\alpha_{54}=0$	3.12**
Except East and Southeast Asia	$\alpha_{51}=\alpha_{52}=\alpha_{53}=0$	2.47*

Notes: * significant at 10 percent; ** significant at 5 percent; *** significant at 1 percent.

Basically, the results are similar between linear and quadratic specifications. Regarding the income growth effect and initial income effect, the tests from quadratic specification conclude that the coefficients are the same except for Sub-Saharan Africa and East and Southeast Asia.

Table 6 re-estimates regression models from Table 4, with the coefficient constraints based on the F tests in Table 5. The results are similar to those in Table 4, but the regional differences in the effect of economic growth on the reduction in gender bias are much clearer. The interaction of income growth with the dummy for Sub-Saharan Africa is significant and positive, while the coefficient on income growth is significant and negative. In the quadratic specification, the coefficients both for Sub-Saharan Africa and for East and Southeast Asia are significant and positive, but the value of the coefficient is much larger in Sub-Saharan Africa, confirming that the impact of income growth on the changes in gender bias in Sub-Saharan Africa is different from other regions.

Table 6. Re-estimate results of restricted regression models

	Linear specification	Quadratic specification
	(1)	**(2)**
ΔlnGNP (α_{10})	-0.071	-0.274
	(3.12)***	(6.29)***
* Sub-Saharan Africa (α_{12})	0.114	0.325
	(2.10)**	(4.76)***
* East and Southeast Asia (α_{14})		0.251
		(2.53)**
ΔlnGNP^2 (α_{20})		0.154
		(5.14)***
* Sub-Saharan Africa (α_{22})		-0.166
		(2.02)**
* East and Southeast Asia (α_{24})		-0.164
		(2.80)***
PreBIAS (α_{30})	-0.757	-0.689
	(14.85)***	(14.27)***
PrelnGNP (α_{40})	-0.065	-0.069
	(6.17)***	(7.29)***
* Sub-Saharan Africa (α_{42})	0.043	0.048
	(1.87)*	(2.14)**
* East and Southeast Asia (α_{44})	0.000	-0.006
	(0.10)	(1.62)
* South Asia (α_{41})	0.024	
	(3.43)***	
* Middle East and North Africa (α_{43})	0.008	
	(2.37)**	
Sub-Saharan Africa dummy (α_{52})	-0.291	-0.369
	(1.99)**	(2.55)**
Constant (α_{50})	1.155	1.159
	(11.86)***	(12.41)***
Observations	355	355
R-squared	0.41	0.43

Notes: The above regression models re-estimate the specification in Table 4, columns (3) and (6), with the coefficient constraints based on the F tests in Table 5. Number of observations: 355 (Sub-Saharan, 87; East and Southeast Asia, 65; Latin America, 140; Middle East and North Africa, 44; South Asia, 19). Absolute value of t statistics is in parentheses. * significant at 10 percent; ** significant at 5 percent; *** significant at 1 percent.

Table 7. Tests for significance of coefficients (inclusive of regional dummies)

		Coefficient	t-statistics
(1) Linear specification			
ΔlnGNP	Sub-Saharan Africa	0.043	0.86
	Non-Sub-Saharan Africa	-0.071	-3.12***
PrelnGNP	South Asia	-0.041	-2.86***
	Sub-Saharan Africa	-0.022	-1.05
	Middle East and North Africa	-0.057	-5.66***
	East and Southeast Asia	-0.064	-6.28***
	Latin America	-0.065	-6.17***
Constant	Sub-Saharan Africa	0.864	6.19***
	Non-Sub-Saharan Africa	1.155	11.86
(2) Quadratic specification			
ΔlnGNP	Sub-Saharan Africa	0.051	0.98
	East and Southeast Asia	-0.023	-0.25
	Other regions	-0.274	-6.29***

Table 7. Continued

		Coefficient	t-statistics
ΔlnGNP^2	Sub-Saharan Africa	-0.012	-0.15
	East and Southeast Asia	-0.011	-0.21
	Other regions	0.154	5.14***
PrelnGNP	Sub-Saharan Africa	-0.021	-0.98
	East and Southeast Asia	-0.075	-7.75***
	Other regions	-0.069	-7.29***
Constant	Sub-Saharan Africa	0.790	5.63***
	Non-Sub-Saharan Africa	1.159	12.41

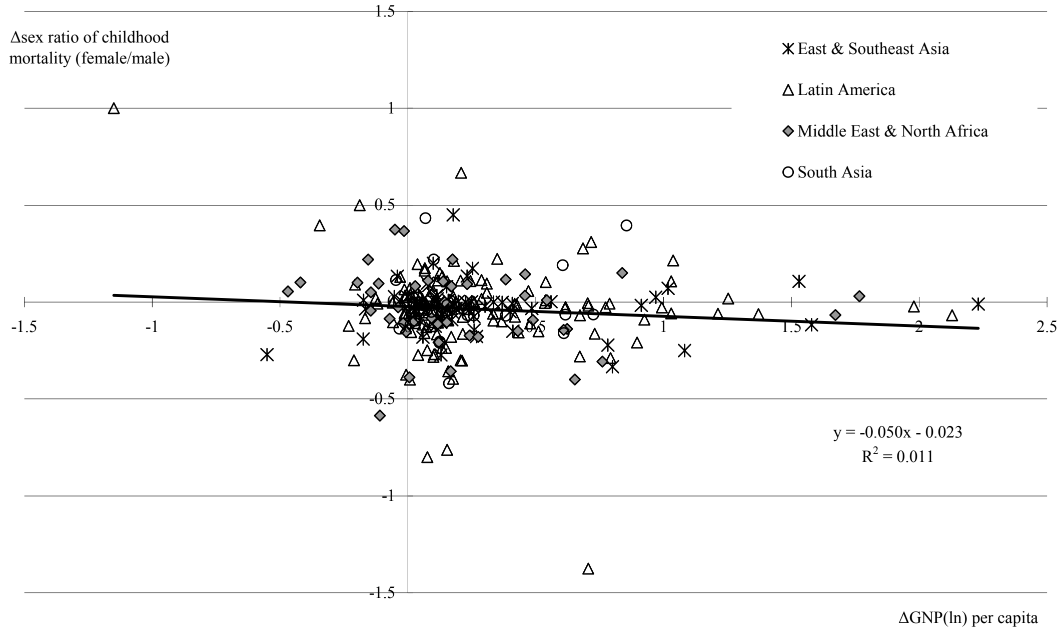
Notes: One-side t test for significance of each coefficient in Table 6. * significant at 10 percent; ** significant at 5 percent; *** significant at 1 percent.

Table 7 shows the value and significance of the coefficient estimates based on the estimation results in Table 6. The test concludes that the coefficient on income growth is not significant in Sub-Saharan; in contrast, it is significant and negative in the other regions. Income growth has a remarkable influence on reducing the anti-female bias in childhood mortality in all regions, except for Sub-Saharan Africa. Furthermore, Sub-Saharan Africa is the only region where the coefficient on the initial income level is insignificant. This means that the level of initial income does not affect the fluctuations in gender difference in childhood mortality in Sub-Saharan Africa. These results reveal that the effect of income growth on the changes in gender bias differs between Sub-Saharan Africa and the other regions. This result explains why most Sub-Saharan African countries have not experienced the anti-female gender bias in child mortality, even though they had been faced with severe economic depression during the 1980s.

The scatter plots in Figures 6 and 7 illustrate the regional differences of Sub-Saharan Africa and the other regions in the effect of income growth on the changes in gender bias. The figures show negative correlation in non-Sub-Saharan Africa with both gross and net effects; moreover, the net effect (direct effect) of income growth on the changes in gender bias after controlling for the effects of initial condition indicated in Figure 6b is better fitted than the gross effect (Figure 6a) in non-Sub-Saharan Africa; in contrast, Figure 7b, which presents the net effect, has much less of a good fit than the gross effect in Sub-Saharan Africa.

Figure 6. The correlation between the change of gender bias and income growth: Non-Sub-Saharan countries

6a: Gross effect



6b: Net effect

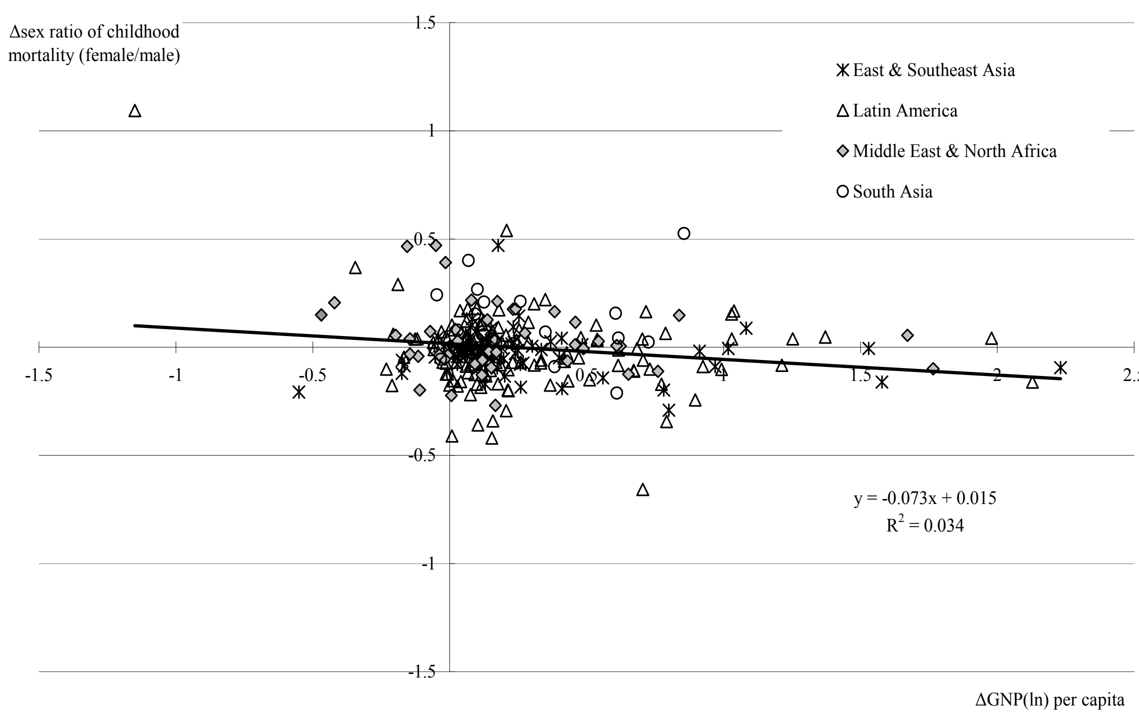
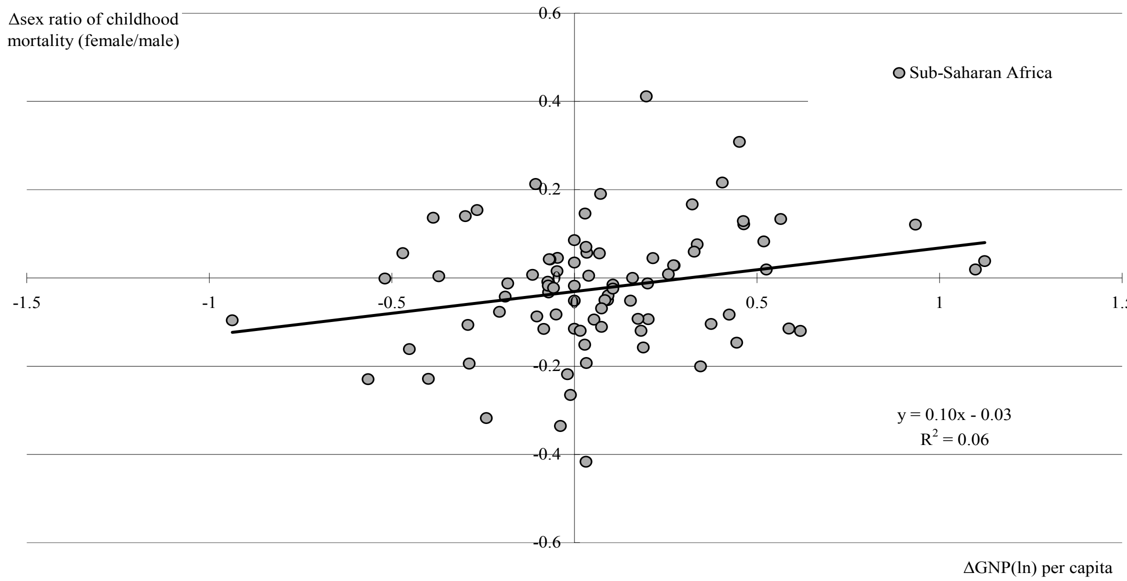
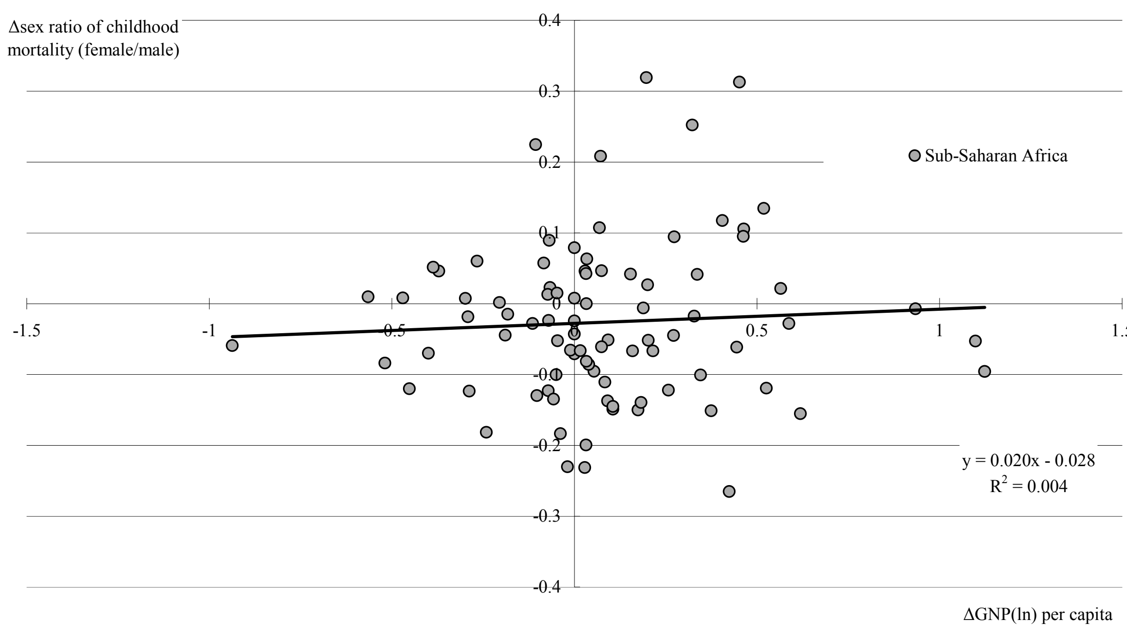


Figure 7. The correlation between the change of gender bias and income growth: Sub-Saharan African countries

7a: Gross effect



7b: Net effect



In summary, income growth has a positive effect on reducing the anti-female gender discrimination in childhood mortality in developing countries, including South Asia, which was considered as a typical region with severe anti-female discrimination. The effects of economic growth and initial conditions on the changes in gender bias in South Asia are similar to the other regions, excluding Sub-Saharan Africa. On the other hand, it has been shown that the extent of the gender bias is not related to income growth at all in Sub-Saharan Africa. These regional characteristics are new facts that have not been addressed by previous analyses focused on the extent of the gender discrimination in South Asia itself and not taking into account long-term changes.

Robustness Check

To check whether the estimation results are robust, this section estimates the same models using the mortality rates compiled from micro information on individual birth and death. The data set used here is an unbalanced panel of 55 countries, covering more than 30 years. The observations for each country are averaged over non-overlapping five-year periods (1966-70, 1971-75, 1976-80, 1981-85, 1986-90, 1991-95, and 1996-2000). The total number of observations is 311, but there is a regional imbalance in a number of observations (16 in Southeast Asia, 75 in Latin America, 26 in the Middle East and North Africa, 28 in South Asia, and 116 in Sub-Saharan Africa). Such a regional imbalance in the data set could lead to somewhat biased results, since the Sub-Saharan Africa is a region in which little gender bias in child mortality existed.

The definition of the dependent variable and explanatory variables are the same as with the previous section. In addition to the childhood mortality rate (between 12 and 60 months), the mortality rate between one and 60 months is used as a dependent variable, since the deaths after the first month of life capture gender discrimination in resource allocation as mentioned before. Table 8 shows the estimation results. In most of the models, the coefficients on income growth (*D*ln*GNP*) are negative and significant. This result is similar to the analysis using aggregated mortality data, which shows that income growth has a significantly positive effect on reducing anti-female bias in mortality. In the model using the mortality rate between one and 60 months as a dependent variable, the coefficient on the interaction term between ln*GNP* and the dummy variable in Sub-Saharan Africa (*SSA_SD1*) is positive (0.17) and it is statistically significant at the10-percent level, while the coefficient on ln*GNP* is significant and negative (-0.20). This suggests that in Sub-Saharan Africa, the impact of income growth on reducing anti-female bias is much smaller than in other regions.

In short, the results show that income growth has a significant effect on reducing the anti-female bias in child mortality in most of the developing regions, including South Asia, while such a relationship is weak in Sub-Saharan Africa. The results are similar between aggregated statistics and originally calculated mortality rates, although regional differences are not shown strongly in the latter case.

Table 8. Effect of income growth on changes in gender bias (OLS), using original estimates for mortality rates

	Dependent variable					
	ΔBIAS (child mortality 2-60 months)			ΔBIAS (child mortality 12-60 months		
ΔlnGNP (α10)	-0.145	-0.186	-0.204	-0.362	-0.322	0.086
	(1.49)	(1.93)*	(2.64)***	(2.22)**	(2.09)**	(0.64)
* South Asia (α11)	-0.588	-0.458	-0.158	0.244	0.109	-0.756
	(1.43)	(1.16)	(0.41)	(0.36)	(0.16)	(1.14)
* Sub-Saharan Africa (α12)	0.003	0.043	0.173	0.196	0.153	-0.091
	(0.03)	(0.36)	(1.75)*	(0.96)	(0.79)	(0.53)
* Middle East and North Africa (α13)	-0.029	0.055	0.235	0.076	0.442	0.203
	(0.11)	(0.22)	(1.02)	(0.18)	(1.01)	(0.43)
* East and Southeast Asia (α14)	0.128	0.204	0.142	0.516	0.578	0.467
	(0.49)	(0.79)	(0.43)	(1.18)	91.39)	(0.83)
PreBIAS (α20)		0.092	0.152		-0.016	-1.241
		(1.03)	(0.98)		(3.07)***	(9.22)***
* South Asia (α21)		-0.617	-1.049		0.012	0.519
		(4.08)***	(5.13)***		(0.97)	(1.26)
* Sub-Saharan Africa (α22)		-0.216	-0.981		0.006	0.194
		(1.89)*	(5.07)***		(0.97)	(1.06)
* Middle East and North Africa (α23)		-0.305	-0.733		-0.011	-0.223
		(1.59)	(1.65)		(0.91)	(0.44)
* East and Southeast Asia (α24)		-0.236	-1.776		-0.028	-0.088
		(0.84)	(2.54)**		(1.13)	(0.21)
PrelnGNP (α30)			0.108			0.011
			(2.51)**			(0.14)
* South Asia (α31)			-0.245			-0.012
			(1.60)			(0.04)
* Sub-Saharan Africa (α32)			-0.133			0.091
			(2.55)**			(0.99)
* Middle East and North Africa (α33)			-0.705			-1.064
			(1.23)			(1.11)
* East and Southeast Asia (α34)			-1.924			-1.665
			(1.93)*			(1.31)
South Asia (α41)	0.067	0.798	2.408	-0.018	0.061	-0.086
	(0.67)	(4.05)***	(3.61)***	(0.11)	(0.29)	(0.07)
Sub-Saharan Africa (α42)	-0.057	0.168	1.579	-0.067	-0.07	-0.637
	(1.23)	(1.36)	(5.20)***	(0.87)	(0.95)	(1.31)
Middle East and North Africa (α43)	-0.02	0.322	4.425	-0.07	-0.049	5.93
	(0.20)	(1.36)	(1.39)	(0.41)	(0.30)	(1.16)
East and Southeast Asia (α44)	-0.04	0.16	11.654	-0.099	-0.187	8.62
	(0.34)	(0.66)	(2.02)**	(0.50)	(0.96)	(1.24)
Constant (α40)	0.081	-0.014	-0.647	0.08	0.056	1.222
	(2.01)**	(0.14)	(2.58)**	(1.19)	(0.88)	(2.93)***
Observations	236	234	178	234	234	176
R-squared	0.05	0.14	0.5	0.04	0.16	0.57

Notes: Number of observations: 311 (Sub-Saharan Africa, 116; East and Southeast Asia, 16; Latin America, 75; Middle East and North Africa, 26; South Asia, 28). Absolute value of t statistics in parentheses. * significant at 10 percent; ** significant at 5 percent; *** significant at 1 percent.

6. CONCLUDING REMARKS

This study examines the relationship between gender bias in child mortality and economic growth. First, the regional trend in the gender bias in child mortality has been updated using new data sets. The data indicate severe anti-female discrimination in South Asia in contrast to a few gender differences observed in Sub-Saharan Africa.

Second, we find new evidence regarding the relationship between income growth and gender discrimination. This is the main contribution of this paper. Only a few studies have focused on regional differences in gender bias in child mortality and the extent in which it responds to income growth. Using a carefully-compiled panel data set, this paper shows that income growth is positively associated with a reduction in anti-female bias in child mortality in most developing countries. This result is reasonable because economic growth brings an increase in nutrition intake (food consumption) and better access to health related inputs.

The most striking finding is that the marginal response of gender bias to income growth in South Asia, where anti-female discrimination is often attributed to cultural and historical factors in the existing literature, is not different from the marginal response in other regions. Therefore, we can expect anti-girl bias in South Asia to decline at a rate similar to those in other regions as income rises. In sharp contrast, the marginal response of gender bias in childhood mortality to income growth in Sub-Saharan Africa is significantly different from other regions. In Sub-Saharan Africa, the marginal response is found to be close to zero, implying the lack of linkage between income growth and changes in gender bias in child mortality.

The previous studies have highlighted the contrast between South Asia and other regions, since acute anti-female gender inequalities exist in South Asia. However, in terms of the linkage between income growth and changes in gender bias in child mortality, South Asia and other regions are not different. However, there is a difference between Sub-Saharan Africa and other regions.

Why is there no anti-female gender discrimination in childhood mortality in Sub-Saharan Africa, and why is economic development irrelevant to the extent of the gender bias there, despite the sluggish performance of Sub-Saharan African economies? What remains to be solved is to clarify the gender discrimination mechanism in Sub-Saharan Africa quantitatively in detail.

As one of the important reasons, I speculate that this could be due to a difference in farming systems, especially the sex division of labor in agriculture. According to Boserup, the farming systems all over the world are historically divided into male and female farming systems, and most Sub-Saharan African countries belong to the latter (Boserup 1970). Gender roles in agricultural production in Sub-Saharan Africa are “sex-segregated,” where women are likely to grow subsistence food crops and men grow cash crops, and each sex is entirely responsible for their crops from the time of production to disposal/marketing; in contrast, gender roles in agricultural production in South Asia are "sex-sequential," where households grow both subsistence food crops and cash crops with different operations assigned to different sexes, and the disposal and marketing are usually controlled by men (Whitehead 1985, 1990). Because of the "sex-segregated" gender roles in agriculture, household food security in Sub-Saharan Africa is a much better guarantee, despite its low income level, and the enhancement of females' bargaining power for food supply might be more influential in food distribution within a household.

Another reason for the absence of anti-female discrimination under the "sex-segregated" gender roles is the following: since the proportion of self-cultivated subsistence crops as a percentage of food consumption is high in Sub-Saharan Africa—owing to women's roles in food crops production—the influence of income on food intake seems to be smaller than for other regions, even when households are faced with decreasing income. In other words, health-related gender discrimination might not be affected much by the income level of a household due to the women's contribution to stability of food supply within the household.

The difference in marriage customs may influence the degree of gender bias in child health. In many Sub-Saharan African societies, payments (wealth transmission) at the marriage normally take the form of bride wealth (bride-price), which is a property transfer from the groom's side to the bride's family instead of the dowry system (a property transfer from the bride's family to the groom's family or to the groom himself), which is very popular in South Asia, especially in India (Goody and Tambiah 1973). Under the dowry system in South Asia, parents are more likely to prefer boys than girls, since raising a girl is more costly.

Finally, a caveat of the analysis in this paper is that we examined only one dimension of gender disparity: gender differences in child health outcomes, especially child mortality. The regional contrast for gender bias in childhood mortality cannot be generalized into other dimension of gender discrimination. Consequently, the empirical result of this study does not mean that gender issues are not serious in Sub-Sahara Africa. Investigating other dimensions of gender discrimination is left for further research.

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